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Can a Self Assessement Tool for Environmental Controls which has been Informed by Users be of Benefit to Potential Users

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Can a self assessement tool for environmental controls which has been informed by users be of benefit to potential users

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M.Sc. in Computing (Assistive Technology)

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1 ABSTRACT

This dissertation looks at the area of environmental control systems (ECS) also known as electronic aids for daily living for people with disabilities. These systems allow an individual with a disability to control devices such as a television, music player, telephone as well as a door, window or curtain controllers. A self-assessment tool was developed for potential users, which was informed by the feedback of (i) users who use or who have used environmental control systems, (ii) Enable Ireland staff who were involved in the service delivery of ECS and (iii) companies who install ECS for individuals with disabilities. These stakeholders were interviewed by a guided interview based on the research on assistive technology models. Results of interviews informed the self-assessment tool development. After the self-assessment tool was developed it was evaluated by potential users to see what benefits it had for potential users.

Key words: *Assistive Technology, Environmental Control System, EADL*

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1.1 Introduction

Having easy access to virtually unlimited information has been one of the greatest achievements to come about in recent times. For example, one such good use is being able to buy products for ourselves. It allows us to research any items to see if it meets our needs and preferences or compare with similar products. This enables us to ask the proper questions and ultimately decide on a product based on our own requirements. This works well when we already have some familiarity of the type of product we intend to buy.

However, when products are not mainstream or they are alien to us, researching product information is much more difficult to do. Not knowing the correct search terms or product features can yield poor search results and leave us lost within our vast online information resource. In this situation, assistance is needed for most of us to guide us to products that may meet our needs. This assistance can be in the way of expert advice or other very useful online resources.

For a disabled person, one need they may have is to acquire assistive technology products. These are products can assist an individual to perform a task or activity that otherwise may be difficult or impossible for them to do. Assistive technology products are generally not yet mainstream products and are not readily available to view within shops. Investigating these products online is a difficult task for the individual who is unfamiliar with what options are available to them. This is why it is important to be guided towards a solution that meets their needs and preferences.

Guidance to a solution may be provided by a multidisciplinary team of experts who assess the individualôs needs and recommend equipment in a person centred approach. However, in reality they are not near enough resources of this type to meet the needs of

the population as individuals with a disability are on waiting lists to meet one-on-one with a therapist.

1.2 ***Background on numbers requiring assistive technology support***

Although figures of disability can vary widely from country to country, there exits two sources of statistical information to estimate global disability prevalence. They are the World Health Survey and the Global Burden of Disease.
(World report on disability -WHO 2011, Global Burden of Disease Update 2004)

The World Health Survey was a face-to-face household survey in 2002ï 2004. Its framework and functioning domains came from the International Classification of Functioning, Disability and Health (ICF). It provides a standard language and framework for the description of health and health-related states. ICF is endorsed by all 191 World Health Organisation (WHO) member states as the international standard to describe and measure health and disability. The cause of health conditions is not focused on, but rather the focus is on the impact that the health condition has on them. Another study of interest, the Global Burden of Disease study was originally commissioned by the World Bank in 1990 to assess the relative burden of premature mortality and disability from different diseases, injuries, and risk factors.

The World Health Survey results give global disability prevalence for the adult population of 15.6%, and for very significant difficulties in functioning it estimates 2.2% of the population. The Global Burden of Disease data estimates global disability prevalence of 19.4% of the adult population and 3.8% is estimated to have a ñsevere disabilityò. The figures are different mainly due to different measurement approaches and assumptions.

Within Ireland there are two surveys that have measured disability prevalence in recent times, the Irish census and the National Disability Survey of 2006. The population census carried out by the Central Statistics Office found that 393 785 people in Ireland

were disabled, a rate of 9.3%. The National Disability Survey which followed afterwards found 11.5% were to have a disability.

The wide variation of prevalence estimates within Ireland and within global surveys is due to the very different measurement approaches and assumptions. Estimates are affected by the type of questions, the level-of-difficulty scale, the range of explicit disabilities, and the survey methodology.

However, it can be seen from all these estimates that the disability figures are relatively high. People with disabilities face difficulties within activities and participation such as learning, communication, mobility, self care, domestic life, interpersonal interactions and relationships etc. For many of these individualsô assistive technology can enable them to participate in social and economic life on an equal basis with others.

The estimates of the population with severe disabilities these are disabilities such as quadriplegia, severe depression, or blindness. Many of these individualsô, assistive technology is essential to have any quality of life and prevent over dependence on family members.

1.3 Goals of providing assistive technology intervention or support

The main purpose of an assistive technology intervention is to enable an individual with a disability to improve their functioning within an activity as opposed to rehabilitation which focuses on the impairment. This could be any daily living activity. For example, if an individual is unable to walk, the focus is not on rehabilitation of the individual's legs, but more on looking at alternative approaches to mobility such as using a powered wheelchair. It does not mean that the individual's potential improvement is ignored as intervention may also look at improving their skill level so as to minimise reliance on technology such as using a walking aid in the this example.

Typically, intervention involves recommending hard and soft technologies. Intervention begins with an assessment of the individual where facts are gathered in relation in relation to the person. The assistive technology (AT) professionals needs to be aware of factors around the person, the technologies and the context of where the technology will be used. The facts are analysed and recommendations are made around technologies. Ideally, the process includes implementation of the system and follow-up with the user afterwards. The main goal for the intervention is to recommend a good match of technology for the person as a mismatch leads to abandonment of equipment.

1.4 Difficulties in providing assistive technology intervention or support

The difficultiesô in providing assistive technology intervention is that it is a time consuming process that uses considerable resources. If a multidisciplinary team is involved it will comprise of a number of the following professions occupational therapist, speech therapist, psychologist, teacher, personal assistant, AT engineer, seating specialist as well as family members of the user.

There are a number of reasons why this is not sustainable:

- AT intervention is not a once off process for the individual with a disability as most situations will change for them over time, such as the abilities to perform activities and their goals to participate in different areas.
- The percentage of the population that have significant difficulties in functioning is increasing due to population ageing and the increase in chronic health conditions.
- The current demands are not being met. Global surveys have shown that even in high-income countries, between 20% and 40% of people with disabilities do not generally have their needs met for assistance with everyday activities.

Another difficulty in relation to providing assistive technology intervention is making sure the individual with a disability plays a large role within the assessment. Research

has shown that a key factor for successful implementation is the role the individual with a disability plays within the assessment. The larger the role during the assessment, then the more likely that the most appropriate assistive devices will be prescribed to meet their needs. (Baum 1998, Gray et al 1998, Scherer 1994)

1.5 Dissertation Aims and Objectives

The primary goal of this dissertation was to investigate the use of a self-assessment tool for individuals with a disability. The self-assessment tool was to assist users with device selection within the Environmental Controls area of assistive technology. Environmental Control Systems (also known as Electronic aids for daily living) are systems that allow an individual with a disability to control devices such as a television, music player, telephone as well as a door, window or curtain controllers.

The proposal was to develop a self-assessment tool which was to be informed by the main stakeholders (i) Users who use or who have used Environmental Control Systems (ECS), (ii) Therapists who have been involved in the service delivery and (iii) Companies who have installed ECS for individuals with disabilities. Interviews were to be conducted to probe users preferences for a self-assessment tool, the process of service delivery therapists have used for Environmental Controls Systems and from ECS companies the equipment they have supplied and specification of equipment etc.
Feedback from interviews was to be analysed to inform how the self assessment tool was to be developed. The developed self assessment tool was to be an online tool which was to ask the user questions. These questions were to relate to the process the therapists use for device selection. On completion of the questions by the user, the self-assessment tool was to send back a report to the user showing details of the ECS products that meet their needs and preferences.
After the self-assessment tool development it was to be evaluated by participants who are potential users of environmental control systems to see if it provided benefits to them. Evaluation was to consist of comparing gold standard approach of ECS service delivery with the use of the self-assessment tool. Pre and post questionnaires were to be completed by participants. The hypothesis is that a self assessment tool that has

been informed by relevant stakeholders can be of benefit to potential users of environmental control systems.

1.6 Structure of dissertation

The remainder of this dissertation is structured as follows:

- Chapter 2: This chapter provides a background to a number of areas. It covers the functional limitations that an individual with a disability may have, their impacts and an analysis of how assistive technology can overcome participation barriers. It examines the MPT service delivery model for assistive technology and provides an overview of Environmental Control systems and their main features. This chapter also explains the characteristics of an Expert System and how logic rules can be used for knowledge representation and provides an overview of the SWI Prolog language.

- Chapter 3: This chapter looks at the sequence of tasks necessary to design, develop and evaluate the self-assessment tool. The issues covered include: interviewing relevant stakeholders to inform the design, designing the self-assessment tool based on their feedback, developing rules to represent the knowledge of the therapist and how the evaluation was performed.

- Chapter 4: This chapter then covers the framework for device recommendation. The rules and variables that were developed are explained along with the reasoning behind the rules based on the research conducted.

- Chapter 5: This chapter goes on to provide an overview of the online self-assessment tool. It covers the technical details and the problems that were faced in turning the rules into reality.

- Chapter 6: Cover the evaluation of the user studies that were performed. It also provides details of the results and discussion around them.

- Chapter 7: This final chapter concludes the study and summarizes. It offers

an evaluation of the contribution to the body of knowledge, the research undertaken and recommendations, and finally opportunities for future research.

2 BACKGROUND: ENVIRONMENTAL DEVICES AND ASSESSMENT TOOLS

2.1 Introduction

This chapter provides a background to a number of areas relevant to this dissertation. It explains some of the terms around disability and shows examples of assistive technology. It describes the MPT service delivery model for assistive technology and provides an overview of Environmental Control systems and explains the main features of the transmitter. Self assessment tools are explained with examples. This chapter also explains the characteristics of an Expert System, how logic rules can be used for knowledge representation and provides a brief overview of the SWI Prolog language.

2.2 Individual with a disability

Disability is not a clearly defined term. There are many different definitions from disability organisations and within legislation. Two commonly used definitions are used below.

The International Classification of Functioning Disability and Health (ICF) define disability as:
ñDisability is a decrement in functioning at the body, individual or societal level that arises when an individual with a health condition encounters barriers in the environmentò.

Within Irish legislation the Disability Act 2005 provideôs the following definition:

ñA substantial restriction in the capacity of the person to carry on a profession, business or occupation in the State or to participate in social or cultural life in the State by reason of an enduring physical, sensory, mental health or intellectual impairmentò.

As pointed out from chapter one there it is a considerable size group as the Irish census of 2006 found that 393,785 people in Ireland were disabled which is 9.3% of the population. In the past disability was looked at from a medical perspective where disability was seen as intrinsic to the person only. It is now looked at from a more social perspective where barriers and negative attitudes are recognise as contributing factors to disability. The ICF has adopted a conceptual framework which is a workable compromise between medical and social models of disability. It considers the

- individuals impairments which are problems in body function or structure
- activity limitations which are the difficulties in executing a tasks and
- participation restrictions which are the problems the individual faces in life situations such as learning, or employment.
- and the individualôs contextual factors; physical, social and attitudinal, which will determine the level of extent of that individualôs functioning

There are obviously numerous impairments that an individual may have within body functions from visual, hearing, mental, neuromusculoskeletal to movement-related functions. For example within movement functions there are motor reflex functions, involuntary movement reaction functions, control of voluntary movement functions, gait pattern functions etc.

When an individual has impairments it may cause a restriction within activities such as learning, communication, self-care, mobility and so forth.
Technology has been developed over the years, in particular in recent years, to overcome many of the challenges faced by individuals with disabilities. Also due to policy and market sense products are being developed with a universal design approach for example accessibility options that are in-built into mobile phones and computer operating systems.

Assistive technology products can be used to enable activities and participation within different areas. Examples of assistive technology are screen readers, hearing aids, tools to assist reading, writing and learning, communication devices, devices to assist with mobility such as walking aids and wheelchairs and devices to assist with daily living such as environmental controls.

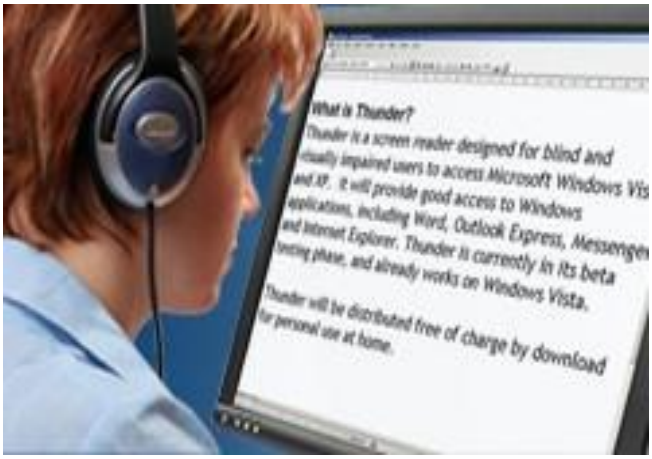


Figure 1 Screen reader/magnifier

Figure 2 Communication device

Figure 3 Power wheelchair

2.3 Environmental Control systems

The term Electronic Aid for Daily Living (EADL) has generally replaced the terms Environmental Control System and Environmental Control Unit. EADL more accurately defines the function of these systems and it doesnôt get confused with the term Environment Controls which is also used to refer to cooling and heating systems within buildings. However throughout this dissertation Environmental Control System will be used as it is more commonly used within Ireland and England.

As already mentioned these systems allow an individual with a disability to control devices such as a television, music player, telephone, door, lights, windows and curtain controllers as well any other electrical device seen around the home. They are generally high tech solutions although low tech solutions are considered within any setup of environmental controls. A suitable positioned handle on the door or extending a window latch with foam tubing are alternatives that can be low cost, easy to setup and do not have a high reliance on technology.

2.4 The technologies

The main parts of any environment control system are the appliance or device that need to be manipulated and the transmitter. The communication between them can be

direct using infra-red or with radio signals, or via a bus system such as Siemens KNX instabus and Z-Wave or communication may be an through IP (Internet Protocol) such as AT&T Digital Life. The advantage of a bus or IP systems is that the state of a device can be known i.e. knowing if a device is switched on or off. This may be useful if it is required to turn on appliances in an upstairs room. A combination of systems is possible and may be required to meet a userôs needs.

However the setup of most environmental control systems in Ireland is where the transmitter directly controls the appliances usually by infrared. This common setup is due to various reasons, the overall cost of setup, ease of setup, less maintenance, and the devices used to control appliances within an IP or bus system are not always accessible. For example some modern interfaces for IP systems use mobile devices such as an iPad. However some users will have difficulty with these mobile devices or the apps they use. The focus of many IP and bus systems seem to be around remote monitoring and for security purposes.

2.5 Transmitter

The transmitter is an important part of the ECS for the user. Selection of components such as a door opener or TVôs are generally flexible, but selection of the appropriate transmitter is crucial. The transmitter provides control to all the appliances within the home or at least all that the user has decides they wish to control. The transmitters are generally learnable transmitters in that they can learn the infra-red signals from other transmitters and so all control of the appliances can be setup from the one transmitter. The selection method i.e. how the user controls the transmitter must suit the user needs and abilities. Selection methods can include direct access, switch access, speech input, or if using a PC based transmitter head control or eyegaze. Direct access refers to where the user presses directly on a button or target area of touch screen to perform some action. Switch access refers to where an external switch is used to interface with a device. Switches can then be positioned anywhere where the user has consistent voluntary movement. Switches are mostly used with a scanning option of the menu except for very simplistic transmitters. For the switch user the scanning menu is the

real interface and this has developed over the years with many customisable options for example the scan pattern, acceptance delay, scan rate or the number of switches used etc.

The following aspects of the technology can influence the success of the person and technology match (Marcia J.Scherer 2003).

- Can the user control their device without pain, fatigue, or inconvenience
- Compatibility with or enhance other supports
- Is safe, reliable, easy-to-use, set up, and maintain
- Has the desired transportability
- no better options currently available
- supports lifestyle and social activities
- available upgrades
- person is not self-conscious about using the device
- person has the skills to use the technology
- appropriate training available
- convenient access to support

2.6 Roles

The main stack holders within an ECS setup are the individual with a disability or customer, the therapist and the supplier. An important aspect for successful selection and implementation of any ECS like any assistive technology are the roles these stack holders play. As stated earlier a key factor for successful implementation is the role the individual with a disability plays within the assessment. The perspective of the individual must be of primary focus and they ideally needs to drive the process of device selection themselves. The therapist who is familiar with AT device selection models will know to consider various characteristics of the person, the technology and the context or environment where it will be used. Their role is to help inform the user of the possibilities and help set user goals while considering all the factors. They may also be involved in setting up equipment trials, acquisition of equipment,

implementation of final system and training. For the supplier their expertise is mainly in relation to the specifications of the technologies available and the installation of the equipment. Most suppliers will supply products from a range of manufactures and so there is less likely-hood of bias towards particular products. Their role is to advice with equipment details, installation pre-requisites and with the installation of the equipment.

2.7 MPT service delivery model

Recommending assistive technology is a complex process which involves considering the inter-relationships between the individual, the activities they wish to carry out, the technology and the context where the technology will be used. Research around abandonment of AT has highlighted the difficulties of this process as abandonment rates of assistive technology have been shown to range from eight percent to 75 percent (Riemer et al 2000).

There are various assistive technologies models that have been developed which detail the various factors that need to be considered. Some models are designed for specific areas such as education while others reflect the broader AT area. Common assistive technology models include Human Activity Assistive Technology (HAAT) Model, The Student, the Environment, the Tasks, and the Tools (SETT) model and the Matching Person & Technology (MPT) Model.

An advantage of the MPT model over some of the other models is that it contains a clear set of checklists which take into account the environments in which the person uses the technology, the individual's characteristics and preferences, and the technology's functions and features. The MPT model is also a well researched and cited model. For these reasons the MPT model was used as the basis for the type of questions used within the self-assessment tool.

As indicated the MPT process contains a series of instruments or check-lists to address the many influences that affect the use of assistive technologies. It is used to

identify the most appropriate technology in relation a userôs needs their goals and the barriers that exist for them. It is a collaborative tool where user and provider work together as each instrument is a pair of instruments, one designed for the user and the other for the technology user. It is applicable across a variety of users and settings. There are a number of technology-specific forms or instruments to help;

- select general purpose assistive technologies.
- students select educational technology in order to reach educational goals.
- employers or vocational counsellors introduce new technologies into the workplace.
- health care providers who recommend or prescribe technologies for health maintenance and pain relief.

The check-lists records consumer goals and preferences which are guided by the relevant influences on the use of technology. Any mismatch between the user and technology provider can be examined. When the most appropriate technology is selected appropriate training strategies can be identified for the user.

A sample of two questions from the instruments are below.
How are your current capabilities in the following areas? Rate on a score of 1 (poor) to 5 (good) for each:

a. vision
b. speech
c. Upper extremity control
d. Mobility
e. Dexterity
f. Physical strength/stamina

How satisfied are you with what you have achieved in the following areas? Rate on a score of 1 (not satisfied) to 5 (very satisfied) for each:

a. Independent living skills
b. Communication skills
c. Physical comfort & well-being
d. Overall health

e. Ability to go where desired
f. Emotional well-being

In the following diagram the MPT author represents the influential factors that need to be considered in order to obtain a good match of technology for a person. The person is symbolised in the centre with their characteristic such as age, functional needs, lifestyle and so forth. This is surrounded by characteristics and requirements of the milieu or environments of use which is composed of the physical, cultural, attitudinal aspects etc. Finally the characteristics of the technology are shown such as the performance, cost, appearance.

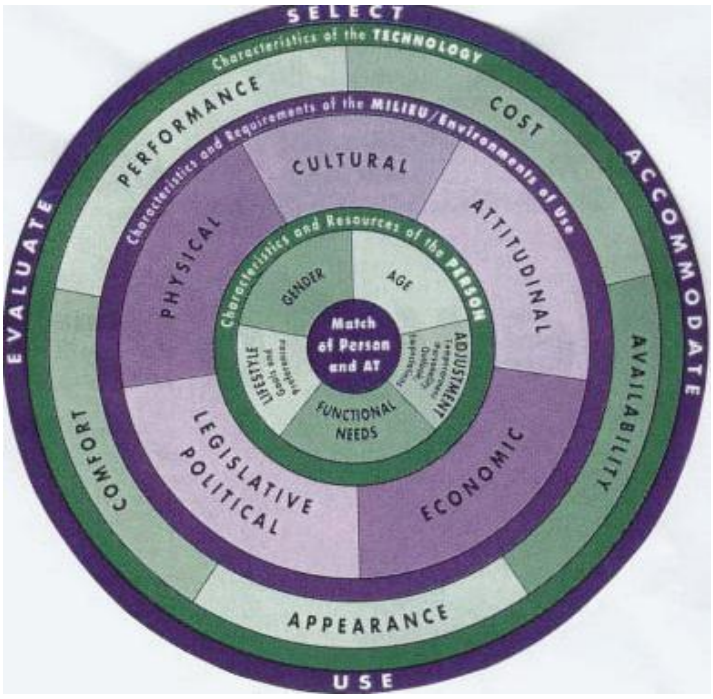


Figure 4 MPT factors

2.8 Self-assessment tools

The definition of self-assessment is an evaluation of one's own abilities and failings. The term is frequently used in a learning context where students make judgements about their own learning achievements and outcomes. The self-assessment is formative and contributes to the learning process by assisting learners to direct their energies to areas for improvement.

In a similar way the self-assessment tool within this study will ask questions in order to quantify the user's abilities in specific areas such as hearing, visual, speech, dexterity, understanding as well as recognising their goals and contextual factors such as what equipment they use with success or whether they have support within home environment.

Within the assistive technology area there are well researched models developed to help match the optimum device for a person. These models detail the various factors that need to be considered and the interrelationships between person, activity, technology and the context. Some of these AT models have developed check-lists or instruments to assist with the process. However, they are designed for the AT profession use or either the use of the user to work through with the AT professional.

There is little in the way of a self-assessment tool within assistive technology where the user can use a tool to work through alone to self-assessment in an informative way. However, two tools that do exist within assistive technology can give a guide of what can be accomplished. One is a paper based tool from CATO (Coalition for Assistive Technology in Oregon) called Hey Can I Try That? And the other is from the ACE Centre Advisory Trust in the UK called Speech Bubble.

Hey Can I Try That? (Bowser & Reed – 2007)

The self advocacy manual is for assistive technology users. It is designed to assist the user to choose and use assistive technology. The student handbook which is a freely downloadable guide is aimed at teenage students who have difficulties with school tasks. It starts out by informing the user that assistive technology is available for then

to help with school tasks such as reading, writing, learning from books, listening, and organizing their work. It doesnôt go all the way in recommending equipment but it does try to encourage self-determination so that once students have identified their goals they will talk to someone who can help them find out about assistive technology.

The manual gets the student to think about their goals by looking at what they are doing, looking at what they want to do better and choosing one activity they want to work on. The manual emphasis points in an appealing way in the form of case studies which provide a brief account of students who have difficulties and what they did. The manual provides space for the student to write down their thoughts on various questions such as;

- where they have difficulties,
- what AT could do for them,
- what AT they have used
- what AT they know other students they know use,
- what they like about AT and things that they don't
- how will they go about meeting their goals

Throughout the workbook they are encouraged to think about the things they want to talk about and questions they need to discuss with parents and teachers.

On review of the handbook the authors do make an assumption that either the student already have a good knowledge of AT, or the students has one-to-one access with teachers who are knowledgeable of AT. This is an unlikely position that student will be in. However on a positive note it does encourage a very user driven approach to AT device selection which is a key component of a successful match of person to technology.

SpeechBubble

This is a project undertaken by the ACE Centre Advisory Trust in the UK. SpeechBubble is a website that aims to provide unbiased information about communication aids. It came about over the difficulty that parents, professionals and users face trying to make properly informed decisions about matching the best

equipment to the needs of the individual. This is due to the growth of communication machines introduced onto the market in recent years.

The website provides a searchable online guide to the technology that can help people with communication disabilities. Its strengths are that it has a well defined set of key searchable options such as;

- speech (digitised, synthesize or not important)
- access (key press, switch scanning, joystick, headpointer)
- compatible symbol library (PCS, Widget, Blissymbols)
- message (symbol, text or both)
- auditory scanning
- Editable dictionary etc.

The tool is an online resource available to anyone. Potential users of communication machines and current users whose needs may have changed can initiate the process of device selection by searching devices that meet their needs. The user selects the options that are appropriate to their needs and the website provides details on communication devices that meet the users search criteria.

The alternative to this type of search is searching through an online database such as Abledata http://www.abledata.com or Assistivetech http://assistivetech.net/ . These are good resources, but searching for communication device will result in hundreds of devices. Searching effectively though a list this size is a feat for the AT profession and for the user unfamiliar with communication devices it is next to impossible. The sub-categories are just not effective enough. This is probably due to the fact that sub categorisation is difficult because items may fall under multiple categories.

2.9 Expert System

Expert systems have been around since the 1970's. They are computer programs designed to model the problem solving ability of a human expert. They typically solve complex problems by reasoning about knowledge, in a similar way that humans reason with knowledge. They are designed around experts who possess a good understanding

in a problem area. They consist of two major parts the knowledge base and the inference engine. The knowledge base contains the knowledge in relation to a specific domain area and the inference engine is the knowledge processor that works with the available information in conjunction with the knowledge from the knowledge base. One of the tasks of designing a knowledge system is to acquire the knowledge from the expert a process known as knowledge acquisition. It is then encoded for the knowledge base using one of several techniques. Rules are a technique for encoding knowledge and a set of rules is one way of representing knowledge in an expert system. A definition of a rule is a knowledge structure that relates some known information to other information that can be concluded or inferred to be known. It is an IF/THEN structure that logically relates information contained in the IF part (the premise) to other information contained in the THEN part (the conclusion). It associates given information to some assertion of new information or some procedure to perform. Rules can have multiple premises joined by AND and OR statements. The solutions can also contain multiple statements jointed by AND.

In the simple example below ñIf the ball is small AND green then the rule infers that the ball is a tennis ballò

IF The ball is small
AND ball colour is green
THEN ball is tennis ball

Expert system problem solving

During consultation of an expert system the ñInterfaceò asks the user questions. The user enters the information on the current problem back via the ñInterfaceò. This goes into ñWorking memoryò which is where the problem facts are stored during a consultation. The ñInference engineò matches the facts that are contained within working memory with the domain knowledge in the ñKnowledge baseò to infer new facts. The new facts are entered into working memory and the process continues until no new facts can be inferred. At this stage the conclusion is added to working memory

as part of the session. The main difference of an expert system and a conventional program is that the knowledge base and inference engine are separate modules. This makes modifying the rules within the knowledge base easy.

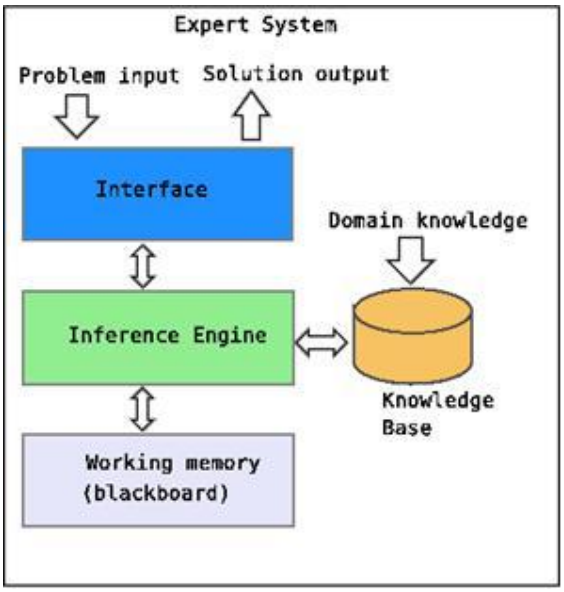


Figure 5 Expert System

2.10 SWI Prolog

SWI-Prolog is an open source implementation of the programming language Prolog. Its is a logic programming language which can run on either Unix, Windows and MacOS X platforms. It has been in existence since 1987 and still in development with a rich set of features. It is well suited for solving problems that involve objects and relations between objects and can be used for Expert Systems.

Prolog has concepts called facts and rules.
Facts are always true
e.g. The following fact ñGeorge is a parent of Seanò can be written in Prolog as follows;
parent (George, Sean).

ñGeorge is a maleò can be written as
Male (George).

Rules are conditional. They specify something that is true, if some condition is satisfied.
e.g. ñX is a father of Y if X is a parent of Y and X is a maleò can be written in Prolog as;

Father(X,Y) :- parent(X,Y) , male(X).

As SWI Prolog is a logical programming language, it is useful for writing rules that encoding knowledge, such as around an expert who possesses a good understanding of a problem area.

2.11 Conclusion

This chapter described the meaning of terms around disabilities and how assistive technology is seen to enable the person with a disability to perform an activity rather than overcome impairment. The technologies used in an ECS were explained - in particular the transmitter. The MPT service delivery model was seen as a preferred model for general assistive technology. The self-assessment tool idea was introduced along with an example of a paper and online based tools. The main parts of an expert system were explained and the logic programming language SWI Prolog was introduced.

3 DEVELOPING A SELF-ASSESSMENT TOOL

3.1 Introduction

The main goal of this research was to see if a self-assessment tool that has been informed by users of environmental controls could be of benefit to potential users of these controls. This chapter details the tasks that were undertaken in order to answer this research question. These tasks encompass the design of the self-assessment tool, the self-assessment tool development, and the evaluation with users. An overview of these three tasks will be presented in these sections below.

3.2 Design tasks

3.2.1 Ethical approval

The initial task within the design phase was to recruit participants that would inform the design of the self-assessment tool. These participants were to consist of the main stakeholders within the selection of a ECS, the user, therapist and suppliers. Participants criteria at the design phase was for (i) Users who had experience of ECS, (ii) Therapists who had experience in the service delivery of ECS and (iii) Companies who had experience of installing ECS for individuals with disabilities. Services users were to be recruited from Enable Ireland and the Central Remedial Clinic. These are two organisations provide services for people with disabilities in various centres around Ireland.

An essential prerequisite to contacting participants was ethical approval which required an application to the two organisations. These applications were designed to capture all the proposed interaction around the user and the details of any user information gathered throughout the study. Along with the ethical approval application, an invitation letter, an information letter, a consent form and interview questions was to be completed. These can be found within the appendices at the end.

The invitation letter for participants was to introduce the researcher and the research and to highlight key aspects in relation to participation. Key aspect included an audio recording of the interview, anonymous responses thereby ensuring confidentiality and that participation was voluntary and withdrawing at any time was possible. The information letter was to contain further information relating the research as well as highlighting again the key aspects above. The consent form was for respondents to give informed consent for participation in the research. The responsibilities for the ECS supplier were outside that of the two organisations and so their interview questions were not required for ethical approval.

3.2.2 Interviews

The main part of the interview questions for the services users was to obtained information relating various design specifics of the self-assessment tool. Design specifics such as whether or not device selection should be ñbest matchò or a number of possible products, the number of acceptable questions the tool would ask, or the format of information feedback to the user. The main part of the interview questions for the therapist was to obtain information relating to the process of device selection, in order to advise with the type of questions the self-assessment tool will ask and with recommendations or solutions that the self-assessment tool will feedback. The ECS supplier interviews information gathering was to obtain information around characteristics of the technology and the suppliers view point of the self-assessment tool.

Interview with therapists required special focus. As the interview time with therapist was limited to one interview it was necessary to be well prepared for the interview. The desired outcome was to obtain information around the process of devices selection for ECS. It was necessary to approach the interview having already a good concept of the process. Various models of assistive technology were to be reviewed. The goal was to select a model that could form the bases of interview questions and ultimately the self-assessment tool. Interviews with therapist was to focus on obtaining their point of view in relation to aspects of the AT model and a more in depth knowledge of the process. Interviews needed to be organised, times and venues

suitable for both the researcher and participant. After interviews the objective was to analyse the interviews of the service users, therapists and the suppliers to obtain key issues relating to the design that would inform the self assessment tool.

3.2.3 Audio recording

Effective note-taking with pen and paper can be difficult at the same time as interviewing. The advantage in audio recording is that it is basically a raw copy of the event or interview and can be analysed with accuracy afterwards. Assuming that consent for audio recording has already been obtained, other ethical issues of importance is around data management. Audio recording was to be stored on an encrypted area of a laptop for secure storage using TrueCrypt. This is open-source disk encryption software that can create a virtual encrypted disk within a file and mount it as a real disk. Also summaries from recordings were to be taken rather than the full transcribing of interviews. Recordings were to be kept only for the duration of research and made accessible only to the researcher.

3.2.4 Rules

The main aim of reviewing the MPT model and interviewing therapists with regard to the characteristic of the person, environment and technology was to be write rules that would enable the self-assessment tool to preform device selections. A rules premise would contain characteristics of the user and the environment and if meet would activate or fire and feedback a solution to the user. The rules effectively try to capture the way of thinking of the therapist. Depending on the rules fired a specific recommendation or solution was to be returned to the user of the self-assessment tool. However it is not possible to do a solution for all the possible combinations of characteristics that can exits so writing the rules was to capture specific cases yet not leave any user without a solution.

3.2.5 ECU Product features

These recommendations or solutions that are feed back to the user requires knowledge of the current devices and their features. The aim was to match the features of current

available ECS devices to the user's characteristics and environment. A selection of similar matches of ECS devices was to form a solution.

3.3 The self-assessment tool development

The development of the self-assessment tool was to implement two main tasks. To write up the rules in Prolog that were created in the design phase and to create a front-end for the self-assessment tool.

3.3.1 Prolog rules

The first of these tasks was to create a Prolog file based on the rules developed in the design phase. Labels were to be assigned for all variables along with its set of values. As well as converting the rules from a IF/THEN logical structure into Prolog syntax, the arrangement of the rules was to lead to the most appropriate rule firing first.
Rules had to be tested with typical data to verify appropriate rule firing and the Prolog file had to be tested with a front-end.

3.3.2 Front-end

The second task was to create a front end in html with embedded PHP. PHP is a widely-used general-purpose scripting language that is especially suited for Web development that can be embedded into HTML. The front-end was to display the questions for the user and to display the recommendation or solution files that were to be returned back to the user. Solution files were to display all the ECS devices identified under a particular solution. ECS devices were to be summarised, suitable pictures found and useful links identified.

3.4 Evaluation of the self-assessment tool

The developed self assessment tool was to be evaluated by participants to see if it provided benefits for potential users of environmental control systems. The main tasks

in organising the evaluations were to request the assistants from local service centre managers within Enable Ireland and make contact with participants, and therapists. A date and time had to be found that suited all involved, and a suitable room booked.

The methodology used was to consist of comparing a gold standard approach of ECS with the use of the self-assessment tool for device selection. Eight participants were to use the gold standard approach and eight participants to use the self-assessment tool. The gold standard consisted of a therapist spending time with participants and assessing their abilities and needs for an ECS and providing a recommendation based on the interview with participant. The self-assessment tool method consists of the participant completing the questions of the self-assessment tool and receiving the solution provided by the tool. With both approaches participants complete questionnaires before and after either the gold standard approach or the use of the self-assessment tool. A pre and post questionnaire was to be designed that would compare the two approaches in relation to the how well the participant felt the approach worked and their satisfaction level with the approach.

In relation to participant criteria the therapist was to have experience in providing recommendations of ECS to service users and in relation to Service Users participation criteria was that they had to be over 16 years of age and that they are potential users of environmental control systems i.e. they would have difficulties in preforming activities such as opening and closing doors or windows etc.

3.5 Conclusion

This chapter provided details of the tasks that are to be undertaken within the research. Before anyone can be approached ethical approval is required from two organisations. The design of the self assessment tool requires preparation of interview question to gather the required information from the users, therapist and ECS suppliers as well as writing rules for device selection. The development tasks consisted of writing the rules in Prolog that were created in the design phase and to create a front-end for the self-assessment tool. The evaluation consisted of comparing gold standard approach

of ECS with the use of the self-assessment tool for device selection. In the following chapters these issues will be expanded upon in detail.

4 A FRAMEWORK FOR DEVICE RECOMMENDATION

4.1 Introduction

This chapter details the framework used within the self-assessment tool and how the research on assisstive technology models and feedback from participants informed its design. It details the design of the questions for the the self-assessment tool, the rules which try to capture a device selection process, and the ordering of the rules so that the most appropriate recommendation is provided.

4.2 Guidance from MPT process

As discussed earlier, the Matching Person and Technology model was seen to have an advantage over some of the other AT models as it includes a clear set of check-lists or instruments. These check-lists or instruments are designed to guide the AT professional during the assessment process for assistive technology. It is also a well researched and cited model of AT and for these reasons it was seen as a suitable instrument that could guide the basis of the interview questions for the therapist and in turn the questions asked within the self-assessment tool. In this model the factors that influence the use and non-use of assistive technologies are the:

1. characteristics of the Milieu which is the context and environment where the AT will be used.
2. features of the individual's personality and temperament and preferences.
3. And the technology's functions and features.

Careful consideration within all three areas is required for matching people with the most appropriate assistive technology. Characteristics within each of the areas can each contribute either a positive or a negative influence on technology use. Too many negative influences will reduce the chance of the technology being successful.

There are a number of instruments available for the selection of technology as detail below:

1. The Assistive Technology Device Predisposition Assessment (ATD PA)
2. The Educational Technology Predisposition Assessment (ET PA)
3. The Workplace Technology Predisposition Assessment (WT PA)
4. The Health Care Technology Predisposition Assessment (HCT PA)

With each instrument there is a pair of instruments, one designed for the provider of technologies and the other designed for the client. Normally what is intended is that the two versions are meant to be used together in order to identify factors that could lead to inappropriate use, or even non-use, of the technology. These are then discussed with the user along with any discrepancies between the two versions. Finally intervention strategies and an action plan are devised to address the problems.

The most appropriate tool for the self-assessment tool is the ñAssistive Technology Device Predisposition Assessmentò (ATD PA) as it has a more general purpose use of AT selection. The content of the ATD PA includes questions that inquire into the userôs subjective satisfaction with the current achievements in a variety of functions areas such as eyesight, hearing, speech etc. It asks the user to prioritise aspects of their lives in which they desire the most positive change, profiles the userôs psychosocial characteristics and asks for the userôs opinion regarding the use of a particular type of technologies. This content along with other factors are considered when trying to hit the ñbulls-eyeò for an optimal match of person and technology.

These influential factors or characteristics that the MPT author highlights where used to form many of the interview questions in particular for the therapists. The pertinent factors for the selection of ECS were used for the interview questions. Within the interview the therapists were asked whether or not the factors needed to be considered and in some cases how they would determine these factors. The questions were organised into characteristics and requirements of the person, characteristics and requirements of the milieu/environment, and the characteristics of the technology (Scherer, M.J., 2004).

An example of the questions are below. The complete set of questions are contained within the appendix.

Characteristics and requirements of the person

- Which areas do you need to know a personôs functional ability?
- How do you determine the personôs strengths and limitations in relation to the functional areas?

Characteristics and requirements of the milieu/environment

- Do you need to know what the supports are within the family or other supports that may be available to the person?

Characteristics of the technology

- What factors do you have to be aware of within a technology
- Is age-appropriateness with equipment an issue with ECS?

4.3 Information obtained from interviews

As mentioned in order to inform the design of the self-assessment tool, individuals who use ECS, therapists who were involved in the service delivery of ECS and suppliers of ECS were first interviewed. All these individuals have many years of experience and so the information feedback was invaluable and provided an excellent basis to develop the self-assessment tool.

For the users the information gathered was around the equipment they use in the home, how well their equipment works for them, key design options for the self-assessment tool and other possible features that the self-assessment tool could have.

Information gathered from the therapists was mainly in relation to the relevant factors from the MPT model and how they would go about determining these factors but they also provided feedback around key design options for the self-assessment tool and other possible features that the self-assessment tool could have.

For the ECS suppliers the information gathered was around the role of the supplier, characteristics of the ECS technologies as well as details on ECS component parts and they also provided feedback around key design options for the self-assessment tool and other possible features that the self-assessment tool could have.

The interviews which lasted thirty minutes each provided a vast amount of information, thus it was not practical to incorporate every aspect. One of the main tasks of the research was to develop a self-assessment tool and so the main concentration when analysing the interviews was around device selection rather than on the other features that the self-assessment tool could have.

A direction to take which had been informed from the interviews was to confine device selection to ECS transmitters rather than focusing on other component parts such as door openers. This is because suppliers have said that they tend to stick to the one door opener or window opener etc. that works well for them as it saves having to be familiar with lots of products or carrying a lot of serviceable parts. For this reason the end-users is more or less limited to what the supplier uses. As for the transmitters suppliers/installers are not confined to a certain brand as they are agents for many ECS manufacturers.

In relation to a self-assessment tool being paper-based verses an online tool, some suggested that both options should ideally be available, but all suggested an online tool. One user comment against paper based tool was ñnot everybody can spell or writeò. Also as highlighted by a supplier an online tool may be the easiest way for the user to access and also the easiest way to show pictures and details on the products.

4.4 Questions for the self-assessment tool

One of the interview questions that was asked to all the six participants informing the design was ñHow many questions are acceptable for the self-assessment tool to ask the user? Less than 10, 10-20, or more than 20ò. Most felt that 10-20 was an acceptable number with some suggesting that the time to complete questions and the interactivity of the questioning could also have a factor on this. This implied that the design of the

self-assessment tool questions had to be ideally under 20 question and ñto the pointò so that they could be quickly completed by the user.

In terms of the questions for the self-assessment tool they were mostly informed by the two therapists that were interviewed. This is because the therapists would have been mostly concerned with the device selection process. There were many good points that were brought up within the interviews that could have informed the selection process however it was not possible to include all and so a selection of some of the key factors were chosen to become questions for the self-assessment tool. These questions and the rationale behind the question are detailed below.

Question to therapists

One of the first questions asked in the interview to the therapists in relation to ECS device selection was:

ñWhich areas do you need to know a personôs functional ability; communication/speech, mobility, dexterity and hand control, eyesight, hearing, reading/writing, understanding and remembering, household activities, and self-care?ò

Response

Therapists said they need to know a personôs functional ability of all the listed items although for for self-care it depends how it was defined. If self-care is defined as calling for help or making telephone calls then self-care is relevant, however knowing if someone can wash, dress, or clean themselves is not that relevant. The relevance of household activities for the therapists is more on what they can or canôt do for themselves in a household environment.

Question to therapists

When the therapists were asked ñAre there any missing functional ability areas required?ò

Response

The following other functional abilities where identified

- Controlled body movement, for example to control switches

- Ability to control devices using head switch or eye gaze
- Abilities to use other assistive technologies, such as their ability to use computers, power wheelchairs, mouth sticks or other aids.

Question to therapists

How do you determine the personôs strengths and limitations in relation to the functional areas above?

Response

To determine the strength or limitation of functional abilities one therapist said this is determine by asking questions such as ñdo you find you need your glassesò, ñdo you have any problems seeing the TVò, or ñreading the newspaperò

Self-assessment tool

This feedback from the therapists suggested that the self-assessment tool needs to obtain all functional abilities listed and that by the use of appropriate questions you could determine its strength or limitation.

This lead to the first set of questions for the self-assessment tool. The first one being related to the users speech where the user is asked to choose the one that best describes themselves and hence determine the strength or limitation.
For example:

Choose one from the following list that best describes your speech?

1. I mostly use a communication machine, or board to help me communicate with others
2. I mostly use my own voice but people sometimes find it hard to understand what I say
3. My voice is clear and people usually always understand what I say.

Each optional answer relates to varies levels of speech starting with non-verbal user to someone with normal speech. For the other functional abilities such as Mobility,

Dexterity/hand control, Eyesight, Hearing, Reading/writing, Understanding/remembering they were questioned in a similar means as above.

For household activities the level was not as important but what they could or couldnôt do for themselves in a household environment and so ten typical household activities were listed for the user to selected whether or not they could do them.
For example:

What household activities can you currently do within your home?
Change the channels on your TV:

1. *no*
2. *some difficulties*
3. *yes*

Open the windows:

1. *no*
2. *some difficulties*
3. *yes*

As for the other extra functional abilities that where identified by the therapists above they are more related to technology use and selection methods for devices, so they were included within questions as follows;

How do you access the technology you use most regularly?

Mouse and Keyboard
Touch screen
Joystick
Switches
Voice input
Headmouse (head controlled)
Eyegaze

Question to therapists

The therapists were asked ñDo you need to know what technology (or other supports) a person currently uses, or have used?ò

Response

The therapists response was ñIn terms of needing to know what technology (or other supports) a person currently uses, or have used this is useful to know as it may be possibly to use existing technology such as wheelchair controls or AAC devices within the ECS. Also it may provide the therapists details of the level of complexity of technology the user is comfortable usingò

Self-assessment tool

The self-assessment tool asks the following question to see what AT is used by the user

Which of the following assistive technologies do you use with success?

Communication device

Power wheelchair

Computer

Environmental Control transmitter

Question to therapists

The therapists were asked ñIt is useful to determine the reason why a user may no longer be using a previous AT interventionò.

Response

The response was ñIt is useful to determine the reason why they are no longer are using the intervention to see if the device was too complex, or is training required rather than a new solutionò.

Self-assessment tool

The following question of the self-assessment tool asked if AT did not work for some typical reasons with the plan that the self-assessment tool would respond back with some advice.

If Assistive Technology did not work out for you, why not?

> *Was there a problem with knowing how too use the AT*
>
> *yes no*
>
> *Was there a problem with accessing the controls*
>
> *yes no*

Question to therapists

The therapists were asked ñHow do you determine an individualôs goals (what they wish to do)?ò

Response

In summery the therapistsô responses were ñask the user what they want at the same time as educating the user of what technologies can do for them. Provide video demonstration as well as showing product pages within websitesò

Self-assessment tool

In order to educate the user of what technologies can do for them, an image was shown of the household activity along with a short description of what the technology can do.

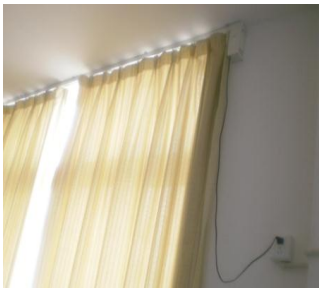
An example of two of the ten household activities is shown below.

> *Below is a list of various items that can be adapted to be easily controlled; select on the items that you would like easier control of within your home.*

Window Opener

Window openers allow any window to be opened using a switch that is placed in a suitable position for the user to reach remote or by using a control transmitter.

Curtain and blind openers



Curtain openers open and close the curtain rail to any position. Blinds can also be controlled. These are accessed from either a switch on the wall or by a remote control transmitter.

Question to therapists and suppliers

ñIs age-appropriateness with equipment an issue with ECS?ò

Response

Therapist said ñAge-appropriateness is important with ECS equipment. Children are likely to prefer colour, while older people may prefer black or duller colours.ò

Both suppliers felt that age appropriateness was an important aspect as ñyoung people tend to like a more sophisticated device such as a smart phone or an iPad where this type of technology is second nature for them. It also allows them to do many other things. Where as an older person it may be more appropriate to have less technical interface with a couple of functionsò

Self-assessment tool

The self-assessment tool asked the following question so that it could take the users age into account when recommending equipment. Rather than ask for a specific age, users are asked to select an age range. In general anyone in the age range 16-50 would be recommended equipment that has a lot of functionality and has a more mainstream looking appearance, while for the over 50 the emphasis was on a more basic device.

How old are you?

2. *Under 16*
3. *16 to 50*
4. *over 50*

Question to therapists and suppliers

ñDo you have to consider the impacts that new technology will have on other members of the home?ò

Response

ñIn terms of considering the impacts that new technology will have on other members of the home, it is not primary concern except in the case of door openers they require patience form others or people will just end up disconnecting themò

Self-assessment tool

The tool asked the simple question of whether or not the user lived by themselves. The plan was to highlight the concern around door openers to people who do not live on their own, that it requires patience for other household users using the door also and so discussion with other household members was advisable.

Do you live alone most of the time?

yes *no*

Question to therapists

ñDo you need to know what the supports are within the family or other supports that may be available to the person?ò

Response

Both therapist agreed that it is something you should find out ñ for training purposes, and support afterwards as user may not have taken everything in at installationò

A comment from a supplier relating to a different question was ñSetting up a TV or a telephone can also take long. Afterwards people may want to change pre-stored numbers within their telephone or change their TV set which will require reprogrammingò

Self-assessment tool

Again this was another simple question. The plan for this question was rather than having an effect on the recommendation process, if user selects ñnoò the tool would feedback to the user that telephones and television may need on-going support as new contacts for the telephone or a new television requires reprogramming.

Have you family or friends who can assist with technical problems?

yes *no*

Question to therapists and suppliers

What factors do you have to be aware of within a technology?

Response

This question was mainly answered by the therapists and included the following factors.

ñmainstream appearance, aesthetics, and simplicity can use easy to understand how to use it, waterproof, battery life, rugged, flexibility of device, can you add on more features, options how things are mounted, are they discreet, extended warranty displays can you see them in the sunlightò

Self-assessment tool

Some of the main factors within a technology seen as being important for the user were included in questions to find the users preference. The factors that were queried were mainstream appearance, easy to use and understandability, robust device that can take knocks, battery life and flexibility of various features and options.

Example

What factors would be important to you in deciding on a new remote control transmitter for your home?

Have a mainstream appearance

2. *not important*
3. *important*
4. *very Important*

4.5 Variables and their levels

In order to work with the data from the online self-assessment tool each question and its response needs to be somehow identified uniquely so that they are all distinguishable from each other. This is accomplished by providing each question with a unique identifier with a fixed set of values as all questions within the self-assessment tool are multiple choice with no open questions.

For example in the following question of the self-assessment tool which asks the users to select an option that best describes their mobility there are five options or levels for the user to select from. The question itself or its variable name is given the identifier ñmobilityò.

What best describes your mobility?

1. *I have no way of moving around by myself*
2. *I mostly use a power wheelchair*
3. *I mostly use a manual wheelchair*
4. *I mostly use a walking aid*
5. *I can walk by myself without any aid*

If the user selects the first option to describe their mobility, i.e. *I have no way of moving around by myself* then the mobility variable will be assigned a value of 1. If they select the second option the mobility variable will be assigned the value 2, and so on.

All the variables are used within the knowledge base. So that a non-programmer can edit the rules, variable names where kept as close as possible to their original meaning. Also the options or levels where given variable values that increased in number depending on the severity of the limitation. So low numbers represented severe limitations and high numbers represented little or no limitation or seen as a strength. All of the functional ability questions are assigned values in a similar way.

Variables that don't have a progressive level are assigned values that would make sense to an AT profession who may need want to edit the rules in order to refine the knowledge base.

For example the variable ñaccess_methodò has the following values;

mouse, keyboard, touch_screen, joystick, switches, voice, headmouse and eyegaze

The full set of variables with and there values are below.

Functional abilities

speech (1-3)
mobility (1-5)
dexterity (1-4)
hearing (1-4)
eyesight (1-4)
eye_deterioration (yes/no)
reading (1-4)
understanding (1-3)

Household activities

activitiestv (yes/no)
activitieswindows (yes/no)
activitiescurtains (yes/no)
activitiesdoors (yes/no)

activitiesentry (yes/no)

activitiestelephone (yes/no)

activitiesmobile (yes/no)

activitieslights (yes/no)

activitiessockets (yes/no)

activitieshelp (yes/no)

Goals

goals (entertainment, windows, curtains, doors, entry, lights, mobile, telephone, sockets, help, none)

Technology in use

technology_in_use (aac, power, pc, ecu)

access_method (mouse, keyboard, touch_screen, joystick, switches, voice, headmouse and eyegaze)

at_dont_know_how (yes/no)

at_cant_access_controls (yes/no)

Personal information

assistance (yes/no)

live_alone (yes/no)

age(child, young, senior)

Preferences

mainstream (1-3)

easy (1-3)

robust (1-3)

battery (1-3)

flexible (1-3)

4.6 Rules

As discussed earlier, one of the tasks of designing a knowledge based system is to acquire the knowledge from the expert - this is a process known as knowledge acquisition. This was accomplished based on the initial research around the MPT model, the use of the Assistive Technology Device Predisposition Assessment instrument and the interviews - in particular with the therapists. This expert

knowledge obtained then had to be encoded for the knowledge base. For the self-assessment tool ñrulesò were used as the technique for encoding the knowledge. A set of 37 rules were written. They are an IF/THEN structure that logically relates information contained in the IF part to other information contained in the THEN part. Rules can associate given information to some assertion of new information or some procedure to perform. In the case of the 37 rules developed for the self assessment tool they perform the procedure of returning a solution or other information back to the user once the conditions are satisfied within the rule.

All the rules are written in SWI-Prolog which is an open source implementation of the programming language Prolog. As will be detailed in the next chapter, the users interaction with the program file is through a web interface. The web interface displays all the questions for the user. When the user has answered and submitted all the questions the facts which are based on the users answers are sent from the web interface and are asserted within the Prolog file. A query is then rule for a solution and this is redirected back to the web interface.

The rules below decide what solution is provided. As mentioned a rule is fired when the premise of the rule or the IF part of the logical structure is satisfied. Whatever rule is satisfied first it conclusion or the THEN part of the logical structure is sent to the user. The rule order in this case is important as only one solution is sent. The most appropriate rule positioned first to be queried first.

One of the questions to the therapists was in relation to other function ability areas that needed to be gathered within an assessment with a user.

<u>Responses from the therapists were:</u>

- ñcontrolled body movement, for example for switches, can they use a head switch or eyegazeò
- ñwhat are their abilities to use other assistive technologies, i.e. their ability to use computers, power wheelchairs, mouth sticks or other aids."

As well as needing to know a userôs basic functional abilities the therapists have suggested a need to find how a user is going to control a devices such as switches,

eyegaze, and what is their ability to use other devices such as computers and power wheelchairs.

For this reason the rules have been based around the current access methods a user has when using for other technologies, i.e. how are they control other devices.
Rule are mainly gathered into the following 3 areas

- people who cannot use their hands
- people who have some hand control
- people who can use their hands

For people who cannot use their hands their access methods for other technologies are usually

  - joystick users already
  - switch users
  - voice input user already OR speech is good

For people who have some hand control their access method is usually

  - direct access via touch screen
  - or directly using increased size buttons

For people who can use their hands access is through standard input methods.

4.6.1 Joystick set of rules

The diagram below represents the set of rules to capture various aspects of a joystick user. For example as can be seen on the diagram a joystick user who has poor eyesight, a joystick user who has reading difficulty etc. with recommendations below the rule. There are 8 rules in this set including a default rule. The default rule is a like a fail-safe so that if the rules in this set do not capture all the specific aspects of the joystick user then this default recommendation will be provided to a joystick user.

The first of these rules from this set is explained in detail and the others are summarised below;

Eyesight

advice(solution20,User):- dexterity(User,'1'),

(technology_in_use(User,powerchair) ; access_method(User,joystick)),

(eyesight(User,'1') ; eyesight(User,'2') ; eye_deterioration(User,yes)).

The Prolog symbol :- is read as IF

The first premise of the rule is *dexterity(User,'1'),*

This refers to the user selecting ñI donôt use my hands to control anythingò to the question ñWhat best describes your ability to control things using your handsò. The comma after the premise refers to a logical AND with the next premise.

The next premise is

(technology_in_use(User,powerchair) ; access_method(User,joystick)),

This refers to a user who successfully uses a powerchair (as they are mostly controlled by joystick) which is logically OR with a user who uses a joystick to access

the technology they use most regularly. This premise again has a logical AND with the next one.

The last premise of the rule is

(eyesight(User,'1') ; eyesight(User,'2') ; eye_deterioration(User,yes)).

In a similar way this last premise refers to a user who has eyesight ranging from blind to the ability to just about make make out characters on the TV screen which is logically OR had a user having an eye condition that will gradually make their eyesight worse.

So in summing up the rule if an individual who does not use their hands to control anything AND who uses a joystick AND has poor eyesight OR failing eyesight then solution20 is recommended to them.

Solution20 will make the recommendation of transmitters with the option for joystick input and that have an auditory scanning feature.

Reading difficulty

The next rule for an individual who does not use their hands AND uses a joystick AND a has reading difficulty

advice(solution30,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),
(reading(User,'1') ; reading(User,'2')).

Solution30 will make the recommendation of transmitters with joystick input and with symbol or picture based menu.

Easy to use and understand

The next rule; for an individual who does not use their hands AND uses a joystick AND needs or prefers an easy to use device

advice(solution40,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),
(understanding(User,'1') ; preference_easy(User,'3') ; age(User,senior)).

Solution40 will make the recommendation of transmitters with joystick input which are easy to understand and use.

Mainstream appearance

For an individual who does not use their hands AND uses a joystick AND wants a transmitter to have a mainstream appearance or is young

advice(solution50,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),
(preference_mainstream(User,'3') ; age(User,young)).

Solution50 will make the recommendation of transmitters with joystick input and mainstream appearance

Good battery life

For an individual who does not use their hands AND uses a joystick AND wants a transmitter with a good battery life

advice(solution60,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),
preference_battery(User,'3').

Solution60 will make the recommendation of transmitters with joystick input and good battery life

Flexible

For an individual who does not use their hands AND uses a joystick AND wants a transmitter to be flexible (with various features and options)

advice(solution70,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),
preference_flexible(User,'3').

Solution70 will make the recommendation of transmitters with joystick input and flexible.

Robust

For an individual who does not use their hands AND uses a joystick AND wants a transmitter to be robust

advice(solution80,User):- dexterity(User,'1'),
(technology_in_use(User,powerchair) ; access_method(User,joystick)),

preference_robust(User,'3').

Solution80 will make the recommendation of transmitters with joystick input and robust.

Default

For an individual who does not use their hands AND uses a joystick

advice(solution90,User):- dexterity(User,'1'),

(technology_in_use(User,powerchair) ; access_method(User,joystick)).

Solution90 will make the recommendation of transmitters recommend transmitters with joystick input.

Rule order

The order of the rules is important. For example the joystick user who has poor eyesight and a preference for a robust device may be unable to access a device if they cannot see the screen. So solutions that meet their needs are transmitters with an auditory scanning feature. If a rule such as preference for robust device had come first then this rule may have fired first. So a robust device could have been recommended over a device with auditory scanning which is an essential requirement. So the most important rules should be listed first that meet specific requirements of the individual with preferences following behind.

4.6.2 Switch set of rules

Similar to the joystick set of rules there is a rule set for switch users. These are rules for users who also select ñI donôt use my hands to control anythingò to the question ñWhat best describes your ability to control things using your handsò and who use a switches to access the technology they use most regularly.

For example;

advice(solution100,User):- dexterity(User,'1'),

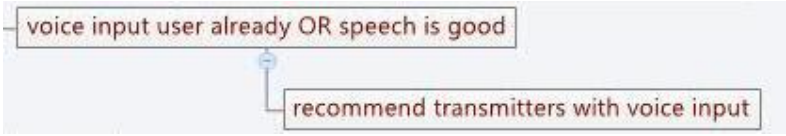
access_method(User,switch),

(eyesight(User,'1') ; eyesight(User,'2') ; eye_deterioration(User,yes)).

The following represent the switch rule set.

4.6.3 Voice rule

For the Voice user there is only one rule because there is a very limited range of device with voice input.



This rule is for individual who does not use their hands but uses their voice as their main access method OR they have good speech quality

advice(solution180,User):- dexterity(User,'1'),
(access_method(User,voice) ; speech(User,'4')).

4.6.4 Touch screen set of rules

Again similar to the joystick set of rules these are rules for touch screen users. These rules are for individuals who have partial hand control and use a touch screen as their main access method.

For example

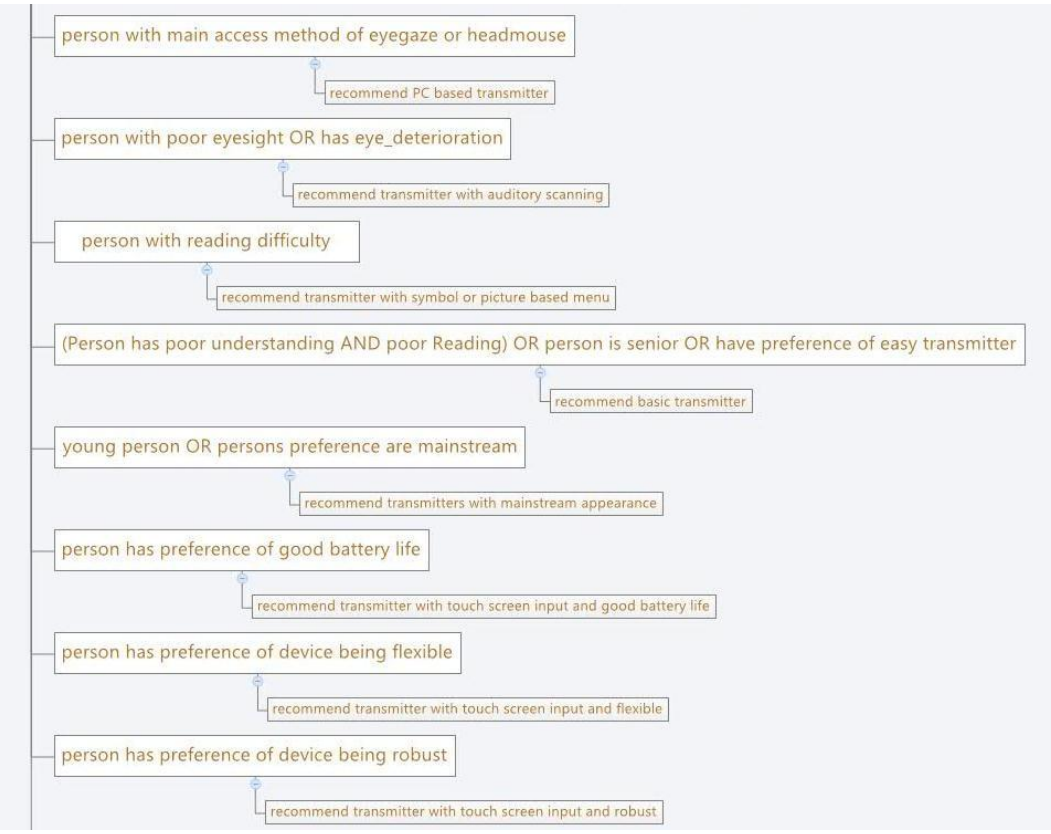
advice(solution200,User):- (dexterity(User,'2') ; dexterity(User,'3')),
access_method(User,touch_screen),
(eyesight(User,'1') ; eyesight(User,'2') ; eye_deterioration(User,yes)).

The following represent the touchscreen rule set.

4.6.5 Good hand dexterity

For the individuals that have good hand dexterity then they can access control through standard input methods and may not rely on specialist controls. As previous rules just

described have looked at dexterity value of 1, 2 and 3 there is only one level left 4 ñI can use a standard remote controlò so it can be assumed that any rule placed after the previous sets of rules are for individuals with good hand dexterity. However although they may be able to use standard input methods uses may have similar difficulties as within the other rule sets such as eyesight issues, reading, understanding, or have device preferences. So it is necessary to have similar rules at this level. One extra rule included is for the user who has an access method of eyegaze or headmouse.



4.7 Conclusion

This chapter discussed the MPT process and how guidance for directing the interviews was obtained. It summarises the type of information which was obtained from participants who were interviewed to inform the design of the self assessment tool and also how the interviews informed the questions of the self-assessment tool. It discusses the variables and levels that were used and finishes with describing the rules of the knowledge base and their order beside one another. In the next chapter we will see how these rules were applied to a deployed self assessment tool.

5 ON LINE SELF-ASSESSMENT TOOL

5.1 Introduction

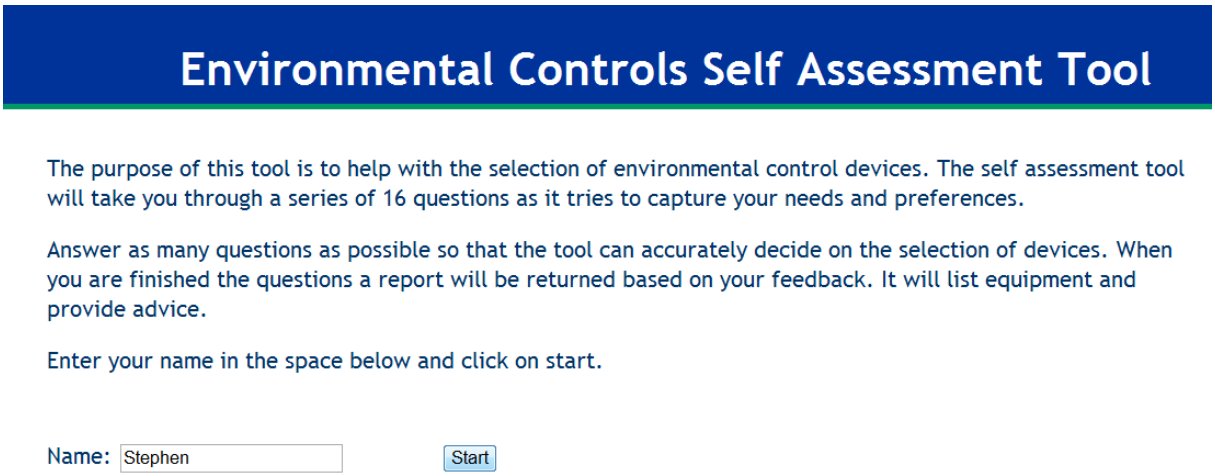
This chapter provides an overview of the self-Assessment tool that was developed with a number of screen shots of the web interface. The technical details are explained in relation to the connection between the web interface, the Knowledge base and the solutions which are send back to the user. Also detailed is how the solution files were put together. The final part of the chapter covers some of the issues with turning the rules into reality.

5.2 Overview of system

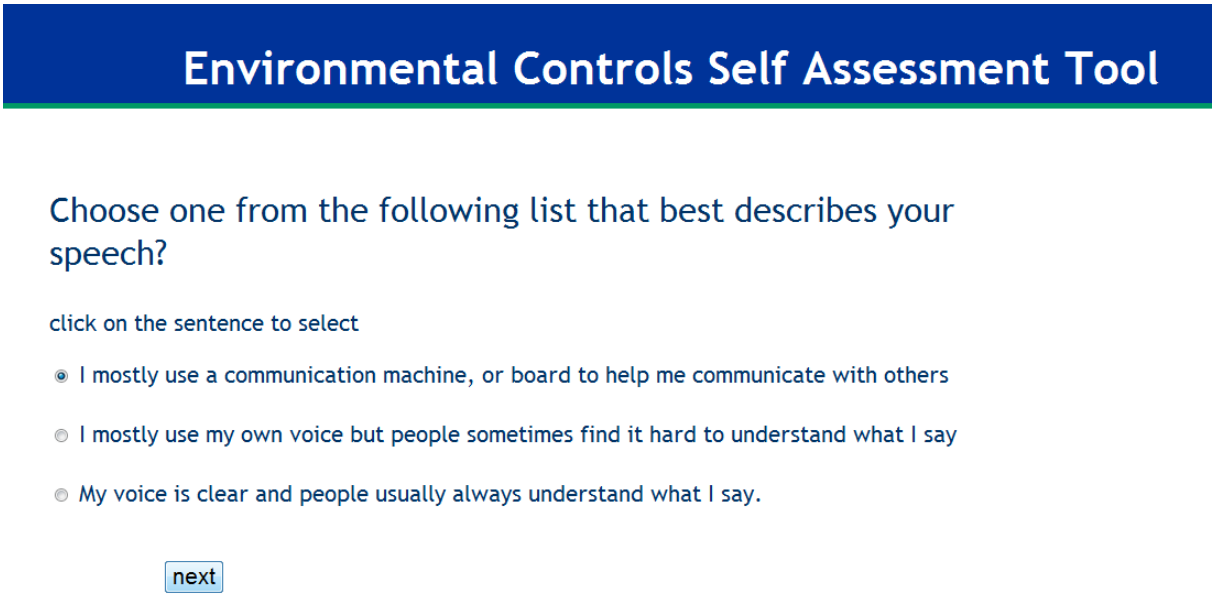
As discussed the main purpose of the self-assessment tool is to assist a user to choose Environmental Control devices. It is a self-directed guide that will lead the user to a set of questions and based on the users feedback the self-assessment tool will automatically determine the most suitable type(s) of technology that will meet the userôs needs. The question for the user will be based on the userôs needs, capabilities, preferences, and the environment characteristic. These characteristics are matched up to the available technology which are displayed to the user.

The interface for the user is a web interface and so access to a computer is a requirement for the user as well as having a connection to the internet. Pages purposely kept as clear as possible with no distractions

The initial screen of the self-assessment tool is shown below. It provides a brief introduction for the user with basic instructions. It requires the user to sign-in with their name and on pressing the enter key or clicking on the ñstartò button the program will progress to the next screen.



The user is then presented with a series of screens that start to gather the users functional abilities their speech, mobility, dexterity, hearing, eyesight, reading, understanding and activities around the home. The first of these screens is shown below, where the user is required to choose one statement from a list of three that best describes their speech.

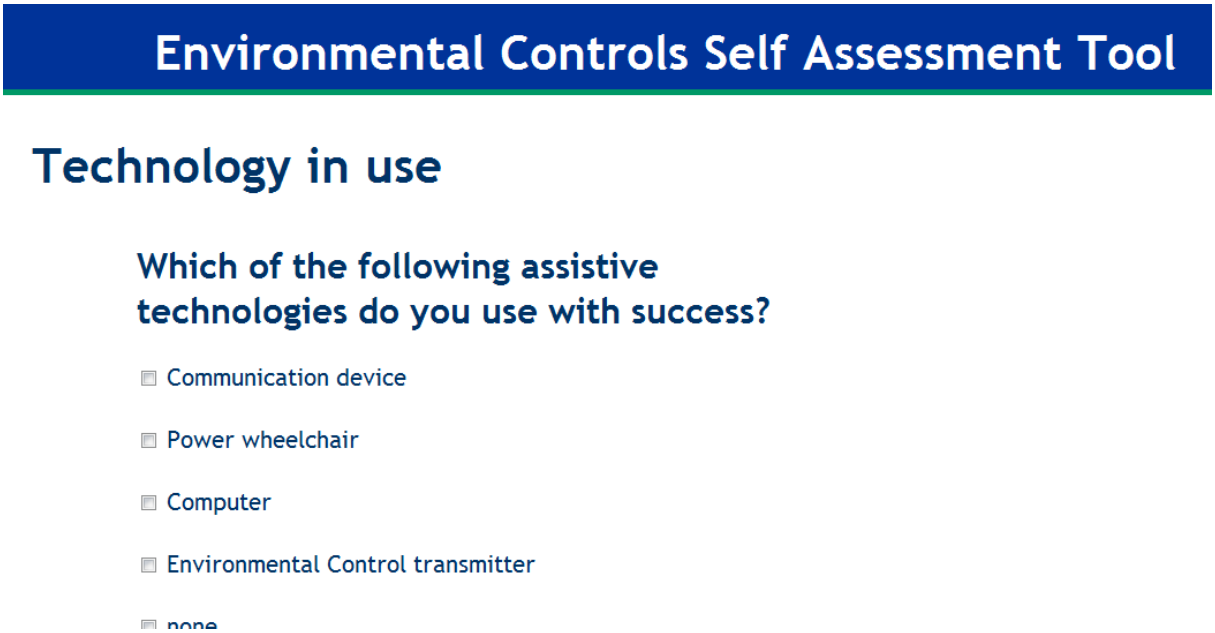


To the left of each statement a radio button can be selected by the user or the statement itself can be clicked in order to select a statement. The statements are generally place in order of severity of the limitation. So low numbers represented severe limitations and high numbers represented little or no limitation or seen as a strength of the user.

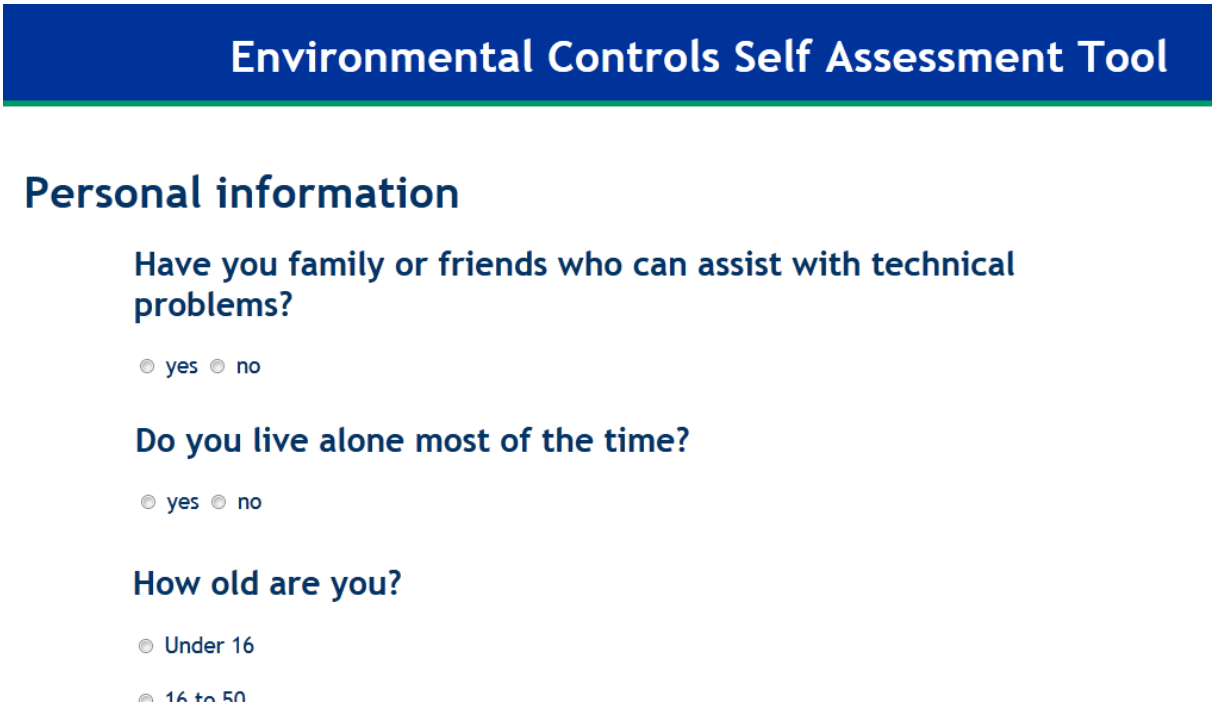
All of the functional ability questions are arranged in a similar manner.

After the user has complete the functional ability screens the user is presented with an option to select goals, or aims they wish to achieve. Here the user is presented with ten typical activities around the home that can be adapted to be easily controlled such as opening a window or door. Each activity is briefly explained with an image to back the text up. A user can express interest in an item by selecting the check-box beside it.

After acquiring the user's goals the next screen gathers information in relation to the technology in use by the user such as what technologies they use and how they access the technologies. Also the self-assessment tool aims to identify problems that may exit in relation to their use of technologies. Some common problems that typically require retraining or a reassessment are listed.



Following the technology in use screen the tool asks the user for personal information such as, can they get assistance, if they live alone and their age.

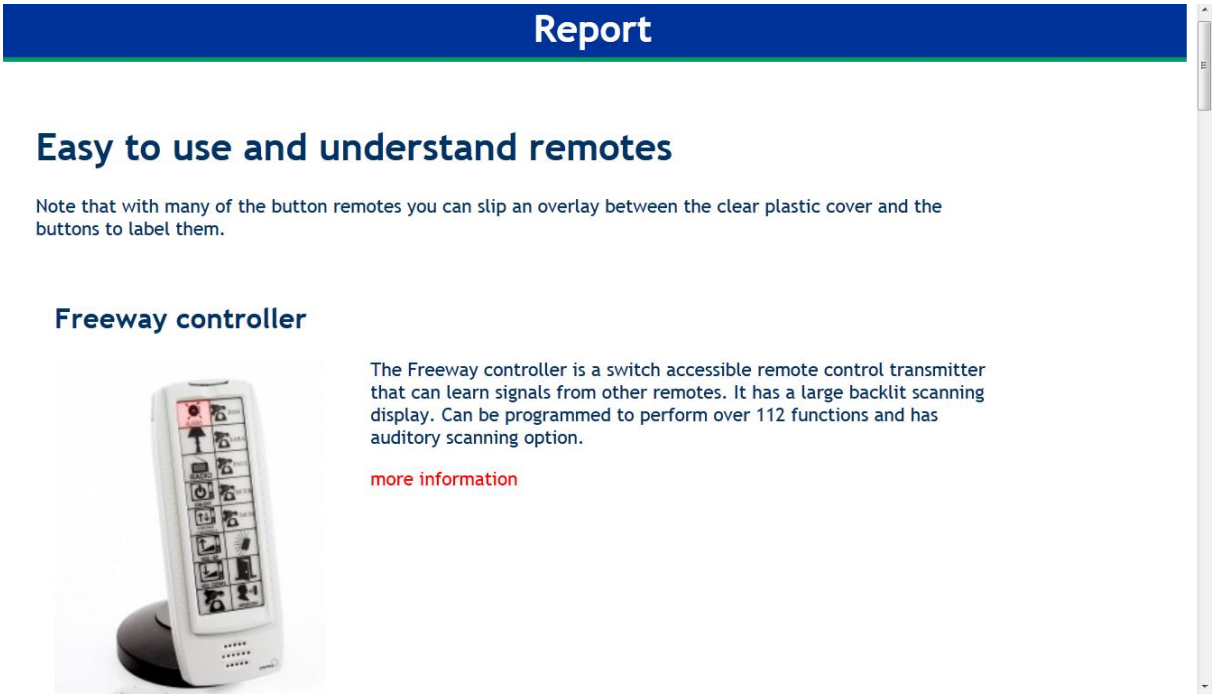


The final screen aims to see what technology characteristics are important for the user; mainstream appearance, robustness, flexibility, and easy to use. When the user clicks on the ñFinishò button all answers to questions are submitted. A solution file will be redirected back to the user.

The Report

The report or solution consist of a file that is redirected back to the user. They consist of a list of ECS transmitters that meet the needs and preferences of the user. This are selected based on the query to the knowledge base. There are a total of 37 solution files contained within the system. Most of these solutions relate to ECS transmitters.

A typical report consists of a number of transmitters that all have particular features identified with them. In this report below it lists transmitters that are easy to use and understand of which there is a total of 11. Each item has a brief description of the product as well as a link to the manufacturers or suppliers website.



The appendix contains a list of currently available transmitters at the time of writing. Each transmitter is cross references to various ECS transmitter features such as mainstream appearance, easy in use and understand, robust, good battery life, flexible, voice controlled, touch screen, joystick and switch input etc. This was used to help create the solution lists.

5.3 Technical details

There are three components of the self-assessment tool. The web interface which contains the question for the user, the Prolog file of the knowledge base and the set of reports or solutions. All were developed using Notepad++ version 5.8 which is a source code editor with support for a number of languages.

The files within the system are comprised of:

- There are 14 PHP files with one CSS style sheet. The PHP files contain text, HTML tags and scripts. PHP is a server-side scripting language. The PHP script is

executed on the server, and the plain HTML result is sent back to the browser.

- One Prolog file which contains the rules.
- 37 solution files which are html files which mostly contain information on ECS transmitters.

The web interface displays all the questions for the user. They are styled by the CSS file. CSS is designed so that document content which is written in HTML is separate from document presentation such as the layout, colours, and fonts. This generally improves accessibility and enables multiple pages to share the same formatting.

The first screen on the self-assessment tool is the Sign-In screen. Its main content is a form which has two input elements, a text field and a submit button. The input text field enables a user to enter text. The submit sends the form data to the URL with the GET method. Form data is visible within the address bar so for example for the user ñStephenò the URL will be as follows:

http://www.speaking-systems.com/sean/q1.php?name=Stephen

```
<form action="http://www.speaking-systems.com/sean/q1.php" method="get">
        Name: <input class="big" type="text" name="name" />
        <input class="big" type="submit" value="Start" />
</form>
```

The next file consists of the first question in relation to the users speech. Again main content is also a form as seen below. There are 5 input elements. Three are radio-buttons with labels which form the answers to the questions, one is a submit button and the last one is an input element that contains the $_GET variable to collect form data ñnameò. Radio buttons let a user select ñonly oneò of a limited number of choices. Again the input data from the form is all send to the next question ñq2.phpò with the GET method.

```
<form name="radio_form" action="q2.php" method="get">
        <input type="radio" name="speech" value="1" id="1" />
```

```
        <label for="1">I mostly use a communication .... </label><br/>
        <input type="radio" name="speech" value="2" id="2" />
        <label for="2">I mostly use my own ..... say</label><br/>
        <input type="radio" name="speech" value="3" id="3" />
        <label for="3">My voice is clear and people .... </label><br/>
        <input type=hidden name=name value=<?php echo $_GET["name"]; ?> >
        <input class="center" type="submit" value="next" />
</form>
```

This continues on from one question to the next where new form data is created and an input elements that contain the $_GET variable collect form data from the previous question and then the GET method is used to send all the data to the next question. When the user has answered and submitted all the questions the form data collected are finally sent to the Prolog file again using the GET method. The form data is asserted within the Prolog file which becomes facts for the Prolog file. A query is then run within the Prolog file for a solution. Depending on which rule fires or whatever rule is satisfied first a solution is then redirected back to the web interface.

5.4 Problems Encountered

1. However one problem found with this setup is that the is a Check-boxes did not carry from one form to the other. Although they were sent using the GET method they were all overwritten using the $_GET variable. So this meant that input elements that were Check-boxes could only have one value.
2. The other general problem for this type of setup for the self assessment tool is that one set of facts are sent to the Prolog file via the web interface and one solution is redirected back to the user. It is not interactive enough. Would be better if data was collected in stages with multiple solutions or feedback send back to the user. So as well as recommending ECS transmitters, providing advice if they have indicated they are issues with use of current technology, or providing specfic advice around a particular AAC device that has ECS

capability.

3. Another issue found is that the tool does not allow non entry of data. The Prolog file expects to see all variables with a value to assert into facts for the file. Where a user to not fill in all data the file will produce an error.

5.5 Conclusion

This chapter provides an overview of the self-assessment tool with the progression through the questions to the report or solution returned at the end. Information gathered from the user relates to their functional abilities, their goals, technology in use, some personal information and their preferences. It shows how screens were kept as simple as possible in terms of the layout of the screen and the language used within the questions. The technical details are explained of the overall system in terms of the files used and their purpose and how answers to questions are passed on form one question to another. The final part of the chapter looks at the main problems uncounted such as the issue with check-box, the lack of user interaction within the self-assessment tool and the issue around non completion of form data.

6 EVALUATION

6.1 Introduction

This chapter covers the evaluation part of this dissertation work. It starts by explaining the evaluation methodology that was used to answer the research question. It then describes how participants were recruited and the process of ethical approval. The results of the evaluation are then detailed with graphs before the results are discussed. Finally some interesting issues which were highlighted through the evaluation are outlined.

6.2 Methodology

One of the main goals of this research was to see if a self-assessment tool that has been informed by users of environmental controls, could be of benefit to potential users of these controls. In order to investigate this hypothesis, an evaluation methodology was designed. It consisted of comparing a gold standard approach to the use of the self-assessment tool for device selection of ECS.

Seven participants were used in the gold standard approach with a therapist while eight participants used the self-assessment tool. The gold standard consisted of a therapist spending about 30 minutes with a participant. The therapist through discussion with the participant assessed their abilities, needs and preferences for an ECS and then provided a recommendation based on the interview with the participant. The self-assessment tool method consisted of the participant completing the questions posed by the self-assessment tool and receiving the solution provided by the tool.

In order to compare the two approaches effectively, pre and post questionnaires were given to the participants before and after either the gold standard approach or the use of the self-assessment tool.

6.3 Participants

The participants for the study were recruited from two organisations, Enable Ireland and the Central Remedial Clinic. These are two non-profit Irish national organisations that provide services for people with disabilities such as physiotherapy, occupational therapy, speech and language therapy or services covering personal development and independent living etc. The criteria when recruiting the therapist for the gold standard approach, required the therapist to be experienced in providing ECS recommendations to service users. In relation to the service users involved in the evaluation, the chosen selection criteria specified that they were over 16 years of age and that they were potential users of environmental control systems, i.e. they would have difficulties in performing household activities.

To obtain participants, ethical approval was an essential prerequisite. In obtaining ethical approval from the Central Remedial Clinic, they requested that participants involved, were provided with comprehensive details regarding the study, and ethical approval also had to be granted by the ethics committee at Dublin Institute of Technology (D.I.T.). Although only one participant was subsequently available from the Central Remedial Clinic, ethical approval was applied for and approved by the Dublin Institute of Technology.

For Enable Ireland the procedure was to complete a research proposal application form for the Research Ethics Committee. Within the application, aspects of the proposed interaction around the user were outlined and confidentiality issues regarding data gathered on participants in the study were detailed. Along with the application supporting documentation was included, such as the proposed invitation and information letter for participants, a consent form and participant interview questions were also included (these are within the appendices). User confidentiality was guaranteed in all aspects of the application as well as voluntary participation.

After six weeks from submission of the application the research proposal was approved by Enable Ireland. This then granted the opportunity to contact local service managers in Enable Ireland centres in relation to inviting suitable participants for the study. Three Dublin based Enable Ireland centres were contacted and participants were invited within each centre. In total 14 service users and one therapist from Enable Ireland participated in the study. The majority of these services users would have have been living in areas relatively close to the centre and so in general most were from the south side areas of Dublin. They ranged in age from 22 to 57 with the majority living with their families. All had primary physical disabilities that would have affected their ability to move their arms, legs or neck etc. All were using power or manual wheelchairs to assist with their mobility. As well as physical disabilities some participants also had speech or visual impairments or learning difficulties. There were no participants with hearing impairments among the group.

6.4 Procedures

As mentioned in the methodology, the use of the self-assessment tool is compared with the gold standard approach by performing similar assessments, to obtain advice on devices based on their needs and preferences. These steps are explained in more detail below.

Use of the Self-assessment tool

The evaluation of the self-assessment tool was the first stage of the evaluation process. It was based within the Enable Ireland centres in Sandyford, Dublin over the course of two days. The local service manager helped to identify service users who were likely to be suitable participants. To make best use of time a list was compiled and a timetable organized for the participants. A dedicated room was booked for the two days which was large enough for table and chair and easy access for wheelchairs. A computer was set up with internet access via a 3G broadband dongle and the online self-assessment tool was displayed. As each service user came in they were given the summary of the study and informed that the session was only for study purposes and not to genuinely assess their needs.

After a rapport was built up the pre-questionnaire was undertaken. The questions were read out to the service user and their answers were recorded in written form. One of the first questions asked, centred around the difficulties they encountered in relation to household activities, such as accessing lights, windows, curtains, TV, opening and closing doors etc. Not all of the service users had difficulties as some of the individuals even though they were wheelchair users, were relatively agile and could stand for some time in order to reach windows or close curtains etc. Where individuals had said they had no difficulties with any household activities, they ideally were not suitable participants. The participant criteria were for individuals who were potential users of ECS, so individuals that said they had no difficulties were thanked for their initial contribution and the session was ended. Where service users had difficulties they were further informed about the study and asked if they were happy to take part. If they agreed to participate they were asked to sign a consent form and the rest of the pre-evaluation questions were asked. The questions related to their previous use of ECS, their knowledge of ECS, the confidence of the self-assessment tool etc.

When the pre-questionnaire was complete, the participant trialled the self-assessment tool. Access to the computer was mainly via the standard keyboard and mouse.
When the participant was at the last question on the self-assessment tool, the ñFinishò button on the submitted all the questions to the Prolog file. The Prolog file then redirected back information in the form of a html page for the participant that would that would meet their specific needs.

There were a number of issues or problems that were noted from the evaluation of the self-assessment tool. One participant required their own alternative joystick mouse to access the computer. Another participant with a more severe disability accessed the internet through their communication machine as it was a PC based device. However there were no wifi spots available to use and there was a reluctance to install the 3G broadband dongle on the userôs communication machine. If the user had an internet connection the participant would have been able to access the self assessment tool as they had full access to navigate and click the mouse cursor and type via an onscreen keyboard. In the case of this participant the questionnaire was completed by the participant reading the questions from the computer that was already set up and

indicating with the communication device his choice of answers. These were then selected on behalf of the user. Another notable problem in using the self assessment tool, involved one participant who found it difficult to make out the text on the screen. By resizing the text size in the browser the participant was able to read the text for himself. Finally, 2-3 participants had some difficulty reading. The reading difficulty ranged from needing assistance with the occasional word to needing the entire questions on the tool read out to them. This reading difficulty also had an impact on how well the returned solutions were understood as it was sometimes necessary to explain the contents of what was presented back to the user.

The final part of the evaluation was the post questionnaire. This was another set of questions similar to the pre-questionnaire with additional questions relating to their satisfaction level with using the tool. As this was in the form of an interview the questions were read out to the participants and notes were taken. On completion of the interview, participants were thanked for their contribution towards the study and the session was ended.

Evaluating with the Gold standard assessment

The second part of the evaluation involved the Gold standard assessment. This was based in two different Enable Ireland centres. A centre in Crumlin and the other in Dun Laoghaire. Again it was run over a two day period. The local service manager within each centre once again supported by identifying service users who were likely to be suitable participants. This initial question asked was to see if service users (participants) had difficulties performing household activities. This gold standard approach followed the same procedure in terms of having a pre and post questionnaire with the assessment in between. These Enable Ireland centres were more open plan than the centres in Sandyford which meant there was limited availability of a dedicated room. Where a room was available it was used, otherwise the questionnaires and the therapist's assessment were given in an area of the centre that was relatively quiet with some privacy for the service user. These evaluations were performed in a less structured way than before, as service users were seen when they were available so as to minimize interruptions to the centreôs activities plan.

In a similar way at the pre-questionnaire stage, the author tried to first build up a rapport with the service user, and then give a summary of the study. They were also informed that the session was only for study purposes and not to genuinely assess their needs. Again the first question to be asked related to their difficulties in relation to household activities. All service users had indicated this time that they had some difficulty and so were suitable as participants. Where a service user had agreed to participate, they were asked to sign a consent form, unless it was obvious this was not possible due to physical disability. Pre-questionnaires were completed with similar questions as used in the evaluation of the self-assessment tool. At this stage one potential participant lost interest and no longer wished to continue and so the session was ended. A number of participants had speech impairments with only one using a communication device. This made the answering of questionnaires considerably longer. However pointing to a scale of 1 to 7 and progressing through the numbers, participants were able to indicate their choices easily for most questions.

When the pre-questionnaire was finished the participants were seen by the therapist. No computer was setup this time as it was not required. The therapist spent 20 to 30 minutes with each service user assessing their needs and preferences and identified typical technology that might be required. The therapist would have recorded details in relation to some of their functional abilities, difficulties that they were encountering, objects that the participant wished to control, and suggested technology for this.

Again the final part of the evaluation was the post questionnaire. This was another set of questions similar to the pre-questionnaire. On completion of the post questionnaire participants were thanked for their contribution towards the study and the session was ended.

6.5 Pre-Survey results

Following the evaluations the study results were gathered and collated for analysis. The pre-survey and post-survey results were gathered on separate tables. The participants were asked to score on a scale of 1 to 7 where 1 represents a low or unsatisfied response and the 7 represents a high or very satisfied response. The pre-

survey results are displayed first below showing the participant responses. The post survey results are shown in a further section.

Each user is displayed within a column of the table with their responses to the questions on each row. The last column provides the average or percentage of aggregate among the participants. Where a blank exists the user did not provide a response.

Table 1: Pre-survey results for Self-Assessment Tool

Pre-survey results for Self-Assessment Tool									
	User1	User2	User3	User4	User5	User6	User7	User8	Avg/%
User has difficulties with household activities	yes	yes	yes	yes	yes	yes	yes	yes	100%
Users already using ECS	no	no	yes	no	no	no	no	yes	25%
Knowledge of ECS	4	5	7	4	3	1	5	6	4.38
Ability of tool to identify the correct products	6	7	7	5	4	4	4	4	5.13
Confidence in tool to provide accurate information	5	3	7	6	2	3		4	4.29
Users that think a therapist would be better	yes	yes	yes	split	yes	no	yes	yes	86%
advantage to find out more about possible solution before meeting an AT resource person	yes	yes	yes	yes	yes	yes	yes	yes	100%

Table 2: Pre-survey results for Gold Standard

Pre-survey results for Gold Standard								
	User1	User2	User3	User4	User5	User6	User7	Avg
User has difficulties with household activities	yes	yes	yes	yes	yes	yes	yes	100%
Users already using ECS	no	no	no	yes	no	no	no	14%
Knowledge of ECS	1	3	2	4	5	4	7	3.71
Confidence in therapist to provide accurate information	7	7	4	7	6	6	7	6.29
Users that think a tool would be better	?	yes	yes	yes	no	split	no	60%
advantage to find out more about possible solution before meeting an AT resource person	yes	yes	yes	yes	yes	yes	yes	100%

Differences in pre-survey results

There are two noticeable differences from the pre survey results between the two groups. One difference is the confidence level of the assessment to provide accurate information to a user. The table and graph below highlighs the participants average rating on the scale of 1 to 7. It can be seen that there is a clear higher expectation that the therapist will provide more accurate information to the user than the self-assessment tool.

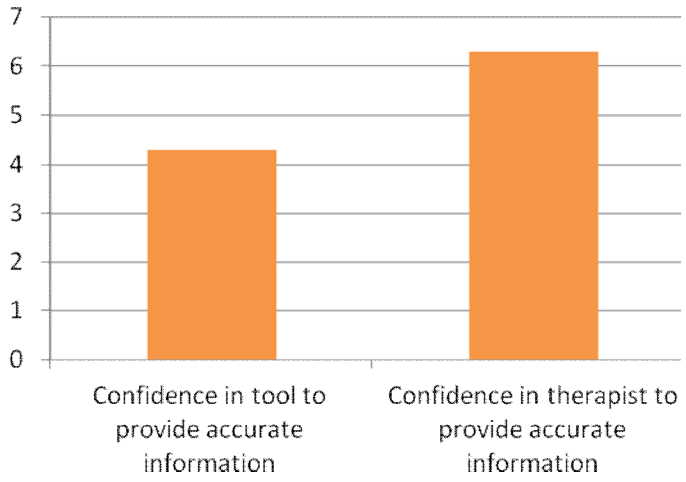


Figure 6: Confidence level of self-assessment tool

The other notable difference is related to the view as to what type of assessment would be better for the device selection of ECS. Both groups were asked similar questions relating to what they thought was the better process. Participants who used the self-assessment tool were asked if they thought a therapist would be better for assisting with device selection and participants who were assessed by the therapist were asked if they though an online tool would be better than a therapist. In comparing the groups there is a significant difference with the majority of participants believing that a therapist would be better as can be seen in the table and graph below.

Table 3 Best assessment for ECS

Best for assessment for ECS	
Users that think a therapist would be better	8 (53%)
Users that think a tool would be better	4 (27%)
Split	2 (13%)
Don't know	1 (7%)

This higher score for the therapist is likely due to the fact that participants feel that a computer cannot logically think like a human and so unable to provide accurate information. Expert systems are not common everyday tools and unfamiliar to the participants.

6.6 Post-Survey Results

The tables below display the results of the post-survey. In this case the participants have already trialled the self-assessment tool or have had an assessment with the therapist. The post survey questions are similar for both the participants using the self-assessment tool and for the participants within the gold standard method.

As before the participants were asked to score on a scale of 1 to 7 where 1 represents a low or unsatisfied response and the 7 represents a high or very satisfied response. Each user is displayed within a column of the table with their responses to the questions on each row. The last column provides the average or percentage of aggregate among the participants.

The first table below shows post-survey results for the self-assessment tool. The next table consists of questions that were used to capture the satisfaction level of using the tool and the third table in this section shows the post-survey results for the gold standard approach. Again there were similar questions within the post surveys that

asking the participants whether they thought the method had the ñAbility to identify the correct productsò and the ñAbility to provide the appropriate adviceò or their ñKnowledge of ECSò.

Table 4 Post-survey results for self-assessment tool

Post-survey results for Self-Assessment Tool	User1	User2	User3	User4	User5	User6	User7	User8	Avg
Knowledge of ECS	6	3	7	6	3	2	6	4	4.63
Ability of tool to identify the correct products	3	5	1	4	5	3	4	3	3.50
Ability of tool to provide the appropriate advice	4	4	2	5	4	4	3	5	3.88
Confidence in tool to provide accurate information	3	3	7	6	6	5	3	4	4.63
Process of using tool to assist in the recommendation of ECS	3	7	7	4	7	5	3	6	5.25
Overall performance of the tool with device selection of ECS	3	4	7	6	5	5	5	5	5.00
Therapist would be better for assisting with device selection	yes	yes	yes	split	yes	yes	yes	no	86%

Table 5 Satisfaction level of using the self assessment tool

Satisfaction level of using the Self-Assessment Tool	User1	User2	User3	User4	User5	User6	User7	User8	Avg
Access and use of the tool	5	6	7	6	4	4	7	6	5.63
Completing the questions	6	7	7	7	5	5	6	6	6.13
Device recommendation and the advice that the tool provides	2	5	7	4	6	7	4	4	4.88
Overall satisfaction with the tool	1	6	7	5	7	7	5	5	5.38

Table 6 Post Survey results for gold standard

Post-Survey results for Gold Standard	User1	User2	User3	User4	User5	User6	User7	Avg
Knowledge of ECS	7	5	2	6	7	5	7	5.57
Ability of therapist to identify the correct products	7	6	7	6	7	7	7	6.71
Ability of therapist to provide appropriate advice	7	7	7	7	6	5	7	6.57
Process of using therapist to assist in the recommendation of ECS	6	7	5	6	7	6	7	6.29
Confidence in therapist to provide accurate information	7	7	6	4	7	6	7	6.29

Differences in post survey results

Within the post-survey results there are two noticeable differences. These differences are the ability of the self-assessment tool or the therapist to identify the correct products and the ability to provide appropriate advice. Participants who used the self-assessment tool were asked afterwards how well did the tool provide appropriate advice for them and how well did the tool identify the correct product. For the participants who seen the therapist they were asked the same question but relating to the therapist. The table and graph below highlights the participants average rating on the scale of 1 to 7. It can be seen that there are significant differences between the self-assessment tool and the therapist in relation to identifying the correct product and the provision of appropriate advice.

Table 7 Ability of assessment

Ability of assessment	Self-assessment tool	Therapist
Ability to identify the correct products	3.50	6.71
Ability to provide the appropriate advice	3.88	6.57

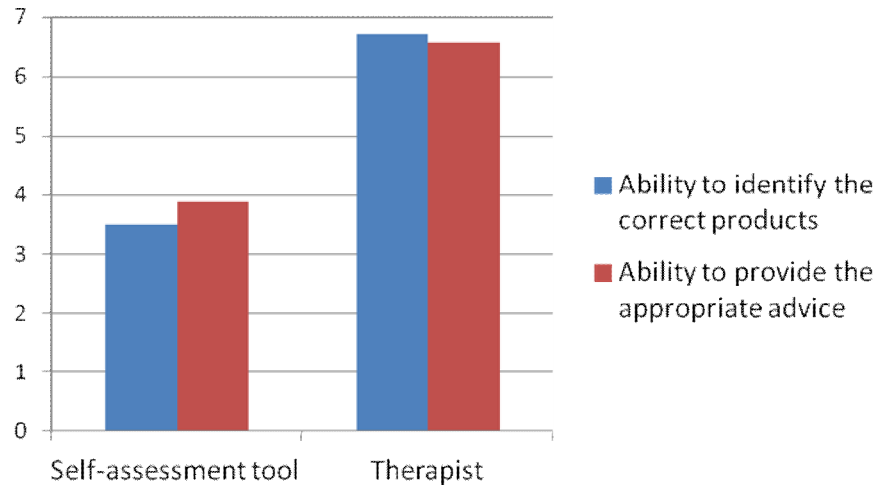


Figure 7 Ability of assessment

There are probable a number of reasons why the self-assessment tool fails to perform on par with the therapist. First of all the self-assessment tool is not a complete working system but more of a prototype that captures a number of important aspects relating to the assessment process. Rules have been written out for these aspects but it still represents only a subset of the knowledge of the therapist. Also the self-assessment tool cannot observe the user unlike the therapist who will partially assess through observation. In relation to providing appropriate advice the therapist can tailor information provided, based on the individual and whether they feel the user understands the advice.

Differences between the pre- and post- surveys

Between the pre and post surveys there are also differences that need to be noted. One difference is the participants ñknowledge of environmental control systemsò between the pre and post surveys. The knowledge level is relatively similar when looking alone at either the pre or post surveys, but looking at the two surveys side-by-side highlights the differences. The table below lists the average score that the participants rated themselves. It can be seen from the table and chart that there is a significant difference between the two groups. Knowledge of ECS for the participants with the therapist is seen to increase considerably more compared to the assessment through the use of the tool.

The reason for the difference may be due to the fact that the self-assessment tool provides only brief information around environmental controls. However if a user had more time to read the solution that is sent back to them and follow the links relating to the products their knowledge of ECS would more likely increase.

Table 8 Knowledge of ECS

Knowledge of Environmental Control Systems		
	With use of tool: A	Gold standard: B
Knowledge of ECS before	4.38	3.71
Knowledge of ECS after	4.63	5.57
Increase	0.25	1.86

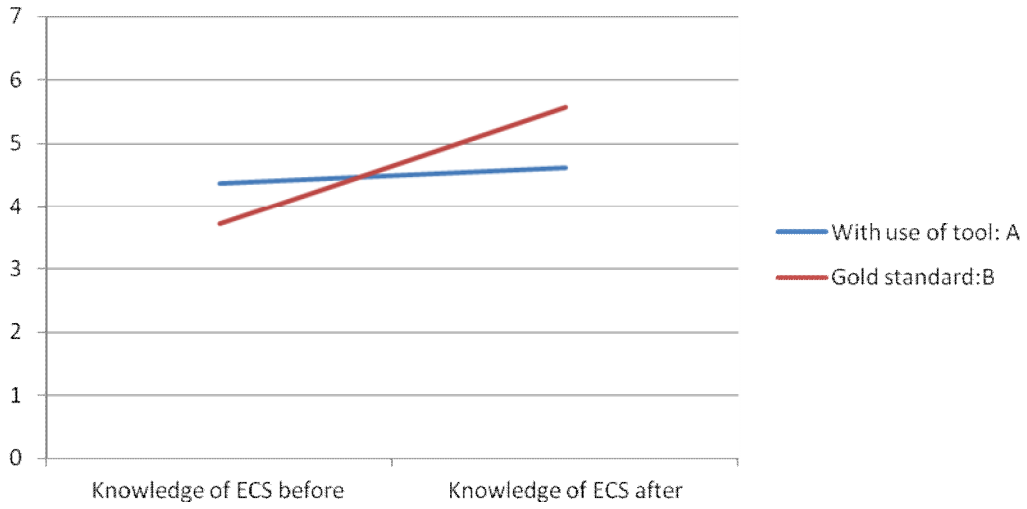


Figure 8 Knowledge of ECS

The other note to make between the pre and post surveys is the participantôs confidence of the assessment to provide accurate information to them. Within each group the participants were asked to rate their confidence in relation to this before and after the assessment. The table and graph below summarizes the participants average rating on the scale of 1 to 7. It can be seen that there is a clear higher expectation that

the therapist will provide more accurate information to the user and even after the assessment this confidence maintains itself at the same high level.

Table 9 Confidence of accurate info

Confidence that accurate information has been provided		
	Pre-survey	Post-survey
Confidence in tool to provide correct information	4.29	4.63
Confidence in therapist to provide correct information	6.29	6.29

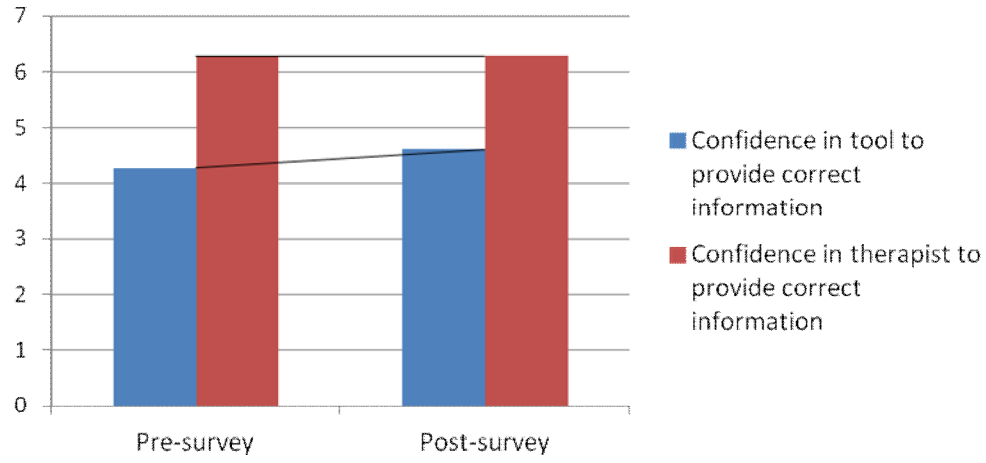


Figure 9 Confidence of accurate information

Finally another point relating to pre and post surveys is the ability of the self-assessment tool to identify the correct products. This was rated by participants before and after using the self-assessment tool. In the table below highlighted in red the average ratings of this ability can be seen to fall 1.63 points to 3.5 after the use of the self-assessment tool.

Table 10 Performance with device selection

Performance with device selection		
	Pre-survey	Post-survey
Ability of the tool to identify the correct products	5.13	3.5
Ability of the therapist to identify the correct products		6.71

6.7 Discussion

From observation of the results it can be seen that the initial expectation of the participants is that a therapist will perform better than the self-assessment tool. Two differences have highlighted this fact from within the pre-survey results. One was the confidence level of the assessment to provide accurate information to a user where there was a considerable higher rating for confidence in the therapist. The other difference was the view as to what type of assessment would be better for the device selection of ECS. It was seen that twice as many participants felt that the therapist would be better for the device selection of ECS. This higher expectation of the therapist is more likely due to the fact that many of the participants are familiar with the support of a therapist and are not familiar with an online self-assessment tool to provide advice. Also literacy level of the participants may have played a part in these decisions. Knowing that a therapist assessment is based on discussion rather than reading a computer screen may have prompted this as a more favorable option.

The post-survey results captured two noticeable differences. These were the ability of the self-assessment tool or the therapist to identify the correct products and the ability to provide appropriate advice. It was seen that there were significant differences between the self-assessment tool and the therapist. For each of these abilities the average rating was nearly twice as much for the therapist. As this was a post survey it shows that based on the participants experience of their assessments, that the self-assessment tool performs poorly compared to the therapist. These abilities of identifying the correct products and providing appropriate advice are essential requirements of an assessment.

When looking at the differences between the pre- and post- surveys there were a number of differences highlighted. Knowledge of environmental control systems for the participants with the therapist was seen to increase considerably more, compared to the assessment through the use of the tool.

Also highlighted when examining across pre and post-survey results, there is a general lack of confidence in the self-assessment tool to provide accurate information. This was highlighted in the results where differences between the two groups could be clearly seen. Although for self-assessment tool the average rating of confidence had slightly increased after the use of the tool, it was still much lower in comparison to the confidence of the therapist to provide correct information.

The last notable difference highlighted from the surveys was the ability of the self-assessment tool to identify the correct products. The average ratings of this ability can be seen to fall after the use of the tool. The participants with the therapist scored nearly twice as much on average as the participants using the self assessment tool (6.71 compared to 3.5). On inspection of the raw data there was one participant score that fell from 7 to 1. However in this case the tool had made a poor recommendation and the participant was aware of that fact.

In summary there are a number of notable differences between the self-assessment tool and the gold standard approach;

- The confidence level that the self-assessment tool will provide accurate information to a user
- The Participants view as to what type of assessment would be better for the device selection of ECS
- The ability of the self-assessment tool to identify the correct products and the ability to provide appropriate advice
- Users gain very little knowledge of ECS from using the self-assessment tool (although removal of unusual data makes it comparable to the therapist)
- Lack of confidence in the self-assessment tool to provide accurate information

The self-assessment tool had compared poorly with the gold standard test in many aspects. However it was a comparison to the best known approach under reasonable conditions. Issues that may have had effected the results are that some of the participants had difficulty reading the questions of the self-assessment screen due to their literacy level which may have turned them away from it as a favourable option. In hindsight, having all the questions automatically read out would have enhanced the self-assessment tool. Also participants are familiar with a therapist and not familiar with a self-assessment tool and so the gold standard test instantly has appeal.

On the positive side of things all the participants scored high on the various aspects of satisfaction in using the self-assessment tool with the overall satisfaction average score higher than 5. Also all participants indicated in the evaluation that that it is an advantage to find out more about possible solutions before meeting an AT resource person. Some participants also gave good feedback in relation to the benefits of using the tool such as;

- ñCentred on me, my choice, I can go through it by myself in my own time and figure it outò,
- ñdonôt need to get helpò,
- ñquick and simple to get information , put me in controlò

These are all strong quotes indicating the individualôs desire for autonomy. Finally another benefit that has not been covered within the research is the cost saving in using the tool. An AT resource person or therapist are a valuable but an expensive resource for an organization.

To answer the research questions the self-assessment tool has been compared with the gold standard. The gold standard has provided a benchmark to compare against. Although the self-assessment tool has compared poorly, the results show some level of user satisfaction with the tool as well as there are a number of other positive aspects. So a self-assessment tool that has been informed by users can be of benefit to potential user but this benefit is limited and does not match an assessment with AT professional.

An interesting point that has come out of the results is that there is a considerable low take up of ECS. The following table and chart shows that 80 % of the participants donôt use environmental controls even though they have difficulties with household activities. Although cost is a factor, the lack of information relating to ECS for users and the lack of professional help are also likely to be significant reasons as well. This is a potential area that the self-assessment tool needs to fill.

Table 11 Use of ECS

Use of environmental controls systems		
	Qty	%
Don't use any ECS	12	80
Number of user from Group A	2	13.3
Number of users from Group B	1	6.7

6.8 Conclusion

This chapter covered the evaluation methodology which compares a gold standard approach to the use of the self-assessment tool for device selection of ECS while using a pre and post evaluation to capture various aspects of the process. It goes on to include the procedure require to recruit participants from two organisations and the profile of participants that assisted with the study. The procedures in relation to the evaluation of the use of the self-assessment tool and the assessment with the therapist were detailed. The self-assessment tool was based within the Enable Ireland centre in Sandyford and the evaluation of the gold standard with the therapist was took part in the Enable Ireland centres in Crumlin and Dun Laoghaire. It went on to detail the pre and post survey results and to highlight differences within the each survey as well as the differences between the surveys. Finally the chapter discussed the results in detail and concluded the investigation of the hypothesis.

7 CONCLUSION

7.1 Introduction

The final chapter summarises the goals of this research in terms of what had been planned and what was actually performed as part of the research. It follows by identifying the research contribution to the body of knowledge, such as the web interface or the set of rules that make up the knowledge base that came about from the investigation of the hypothesis. Following on, the limitations of the study are discussed, in terms of where the study falls short. Finally the chapter finishes by looking at future work and recommendations.

7.2 Research Definition & Research Overview

The primary goal of the research in this dissertation was to investigate if a self-assessment tool which has been informed by the main stakeholders (i) Users who use or who have used Environmental Control Systems (ECS), (ii) Therapists who have been involved in the service delivery and (iii) Companies who have installed ECS for individuals with disabilities can be of benefit to potential users.

To accomplish this research participants were recruited from Enable Ireland and the Central Remedial Clinic. Interviews were guided by the Matching Person and Technology assistive technology model. Interviews were conducted to probe user's preferences for a self-assessment tool, the process of service delivery that therapists use for ECS device selection and ECS companies were interviewed regarding the equipment they supplied etc. Feedback from interviews was analysed to inform how the self assessment tool was to be developed.

After development it was evaluated by participants who were potential users of ECS. Evaluation consisted of comparing a gold standard approach of ECS with the use of the self-assessment tool. Pre and post questionnaires were to be completed by participants to effectively compare the two. Results from the evaluation showed that

the self-assessment tool had compared poorly with the gold standard test in many aspects. However the results show some level of user satisfaction with the tool and there were some other positive outcomes with the self-assistive tool. The results concluded that a self-assessment tool that has been informed by the main stakeholders can be of benefit to potential users but this benefit is limited and does not match an assessment with an AT professional.

7.3 Contributions to the Body of Knowledge

This study has investigated a self-assessment tool that has been designed by the main stakeholders can be of benefit to potential users. From the investigations the study has led to achieving a number of results;

- By interviewing a sample of the main stakeholders, valuable interview summaries regarding a userôs preference, the process used by therapists for device selection and technical aspects of the ECS technologies have been obtained. Information obtained could inform other projects related to ECS.
- The Matching Person and Technology MPT assistive technology model has been examined and the influences relating to user characteristics, technology characteristics and the aspects of the Milieu have informed in particular the interview with therapists. Data has been gathered on the process used for device selection.
- A set of questions for the self assessment tool has been developed. These all relate to the feedback from the interview questions.
- A complete self-assessment system comprising of a web interface, knowledge base and solution files were developed.
- A comprehensive matrix showing a list of current ECS transmitter verses appropriate features were developed. This can be used if further solution pages need to be created.
- A knowledge base formed by 37 rules was designed to select a solution that fits the user needs and preferences. All rules have comments that describe the rule and all variables have clear labels to be easily recognizable.

- The Pre and Post questionnaires given to each group based on comparison of the self-assessment tool with the gold standard test for ECS device selection.
- Results of Pre and Post surveys.
- The analysis of results in order to examine the hypothesis.

7.4 Limitation

There were a number of limitations to the research at various stages of the dissertation. Some of these issues could have been dealt with further work although some were unavoidable.

- If more evaluations had been carried out, the more accurate results would have been. There were only 7 participants for evaluation of the gold standard test and 8 for the self-assessment tool. This was mainly due to time commitments and the lack of local participants. Participant numbers in Dublin were limited, and evaluating with further participants would have involved travelling to further Enable Ireland centres such as those based in either Galway, Limerick or Kerry. These centres would have had a number of possible participants, but would have meant contacting the local service managers, arranging dates and room which is a time consuming process.
- The number of evaluations using the gold standard test was limited due to the need of a therapistôs involvement and their own time commitments. The seven evaluations that had taken place using the gold standard test had already taken up about a day and a half of the therapists time. Therapist are valuable resources for an organisation and their time is split across the organisation.
- After analysing results of the questionnaire, it was noticed that a question could be open to interpretation in different ways. Ideally questions should be all tested with participantôs first to see that the questions are clearly understood before committing to a set of questions.
- No text to speech option on the web interface for the the self assessment tool. There were a number of users that required the questions and answers read out to them. Even though language was kept relatively simple some user had

difficulties reading. Ideally users should have the option to have all questions and answers read out to them through a text to speech option. This would allow more users to independently use the self-assessmetn tool. been read out for the user for some user for During the Read out the question to the

- Also there was no text resizing option on the web interface of the self-assessment tool. One participant had difficulty with reading as they were more comfortable with a larger text size. Although text size can be increase within the browser it is not obvious how to do it. Having a dedicated icon at the top of the web interface could allow a level of customising to suit needs.
- The assistance that the self-assessment tool provides is only recommendations on suitable transmitters.
- Limited interactivity with the web interface. Just provides only a report and has no other features.
- Rules were confined due to technical issues with not being able to use checkboxes within the forms of the web interface.
- Some of the participants had mild learning disabilities which may have affected their ability to fully comprehend and answer questions during the surveys. This may have affected some of the results although the participants were reflective of Enable Ireland service users.
- The comparisons of the results were only based on comparing averages rather than any statistical methods.
- The participants came from two similar organisations who provide services for similar disability groups. The participant groups would not have been represented a random sample from the disability population.

7.5 Future Work & Research

The self-assessment tool does have the potential to become an effective tool to provide advice for people with disabilities. Individuals may need help to live independently or live with more comfort and safety within their own home environment. However there

are a number of improvements which could form areas for future work and research. Some of these areas are below:

- There are a few improvements needed for the web interface such as including a text to speech option so that a user can have the questions and answers read out to them. Also include and an option at the top of the page to enlarge or decrease text size in order to suit the user. This would allow more users to independently use the self-assessment tool.
- The assistance or recommendations covered by the self-assessment tool should be expanded to include other factors related to ECS setup. Such as if a user has indicated they are a switch user then the tool could also provide advice on switches or mounting options.
- Developing a more interactive web with more features would give more user satisfaction as well as provide a more useful site. There were a number of features that were highlighted in the interview summary within the appendix that could be included such as as the option to browse products by category or a comparison of products .
- The technical issues regarding using check boxes within the web interface needs to be fixed. This was highlighted in section 5.4. This can confine the way rules are written.
- The results could be improved by using statistical methods such as the T-test to compare the means between the groups.
- For further evaluations other organisation should be contacted such as the National Rehabilitation Hospital in order to get a wider group of disabilities represented in the results.
- Finally before further evaluations questionnaires should be tested with some participants first to see that the questions are clearly understood before committing to a set of questions.

7.6 Conclusion

This chapter covered the research definition and overview. It goes on to highlight where the research has made contributions to the body of knowledge such as the development of a self-assessment tool and the results of the questionnaires. Following that it identifies a number of limitations to the research at various stages of the dissertation. Finally it lists future work and research so that the self-assessment tool can become an effective tool to provide advice for people with disabilities.

BIBLIOGRAPHY

Bratko, I., 2001. *Prolog Programming for Artificial Intelligence*, Pearson Education.

Chiu, H.-P. et al., 2010. Essential Needs and Requirements of Mobile Phones for the Deaf. *Assistive Technology*, 22(3), pp.172ï 185.

Cook, A.M. & Hussey, S.M., 2002. *Assistive technologies: principles and practice*, Mosby.

Durkin, J., 1994. *Expert systems: design and development*, Macmillan.

Jerome, J., 2011. Simple Solutions: Home Automation Technology for Easy, Safe, and Accessible Living. *Design Research and Methods Journal*, 1(1). Available at: http://design-dev.ncsu.edu/openjournal/index.php/redlab/article/view/95 [Accessed February 6, 2012].

Jonge, D.D., Scherer, M.J. & Rodger, S., 2007. *Assistive Technology in the Workplace*, Elsevier Health Sciences.

von Maltzahn, W.W., Daphtary, M. & Roa, R.L., 1995. Usage patterns of environmental control units by severely disabled individuals in their homes. *IEEE Transactions on Rehabilitation Engineering*, 3(2), pp.222ï 227.

Matthews, B. & Ross, L., 2010. *Research Methods: A Practical Guide for the Social Sciences*, Pearson Longman.

NDA, Paper 10: Key Factors for Successful Implementation of Assistive Technology in Education. Available at: http://www.nda.ie/cntmgmtnew.nsf/0/8019CCA62FED21158025706600506DFC?OpenDocument [Accessed July 1, 2012].

Nielsen, J., 1994. *Usability engineering*, Morgan Kaufmann.

Østensjø, S., Carlberg, E.B. & Vøllestad, N.K., 2005. The use and impact of assistive devices and other environmental modifications on everyday activities and care in young children with cerebral palsy. *Disability & Rehabilitation*, 27(14), pp.849ï 861.

Phillips, B. & Zhao, H., 1993. Predictors of assistive technology abandonment. *Assistive technology: the official journal of RESNA*, 5(1), pp.36ï 45.

Possum. Available at: http://www.possum.co.uk/ [Accessed February 6, 2012c].

Rigby, P. et al., 2005. Impact of Electronic Aids to Daily Living on the Lives of Persons With Cervical Spinal Cord Injuries. *Assistive Technology*, 17(2), pp.89ï 97.

Ripat, J., 2006. Function and impact of electronic aids to daily living for experienced users. *Technology and Disability*, 18(2), pp.79ï 87.

Scherer, M.J., 2004. *Connecting to Learn: Educational and Assistive Technology for People With Disabilities*, American Psychological Association.

Scherer, M.J., 2005. *Living in the state of stuck: how assistive technology impacts the lives of people with disabilities*, Brookline Books.

Stickel, M.S. et al., 2002. Toward a comprehensive evaluation of the impact of electronic aids to daily living: evaluation of consumer satisfaction. *Disability & Rehabilitation*, 24(1-3), pp.115ï 125.

Story, M., Mueller, J. & Mace, R., 2011. The Universal Design File: Designing for People of All Ages and Abilities. *Design Research and Methods Journal*, 1(1). Available at: http://design-dev.ncsu.edu/openjournal/index.php/redlab/article/view/102 [Accessed February 6, 2012].

Tithe an Oireachtais, Disability Act 2005 - Available at: http://www.oireachtas.ie/viewdoc.asp?DocID=4338 [Accessed July 2, 2012b].

Verdonck, M.C., 2012. The meaning of environmental control systems (ECS) for people with spinal cord injury: An occupational therapist explores an intervention. Available at: http://cora.ucc.ie/handle/10468/582 [Accessed June 30, 2012].

Verdonck, M.C., Chard, G. & Nolan, M., 2011. Electronic aids to daily living: be able to do what you want. *Disability & Rehabilitation: Assistive Technology*, 6(3), pp.268ï 281.

WATI Resources, Assistive Technology - Available at: http://dpi.wi.gov/sped/at-wati-resources.html [Accessed July 4, 2012a].

Web Accessibility Initiative (WAI) - home page. Available at: http://www.w3.org/WAI/ [Accessed February 6, 2012d].

Wellings, D.J. & Unsworth, J., 1997. Fortnightly review: Environmental control systems for people with a disability: an update. *BMJ*, 315(7105), pp.409ï 412.

WHO | Global burden of disease. *WHO*. Available at: http://www.who.int/topics/global_burden_of_disease/en/ [Accessed July 24, 2012e].

WHO | World Health Assembly resolution WHA58.23 on disability, including prevention, management and rehabilitation. *WHO*. Available at: http://www.who.int/disabilities/publications/other/wha5823/en/index.html [Accessed June 30, 2012f].

WHO | World report on disability. *WHO*. Available at: http://www.who.int/disabilities/world_report/2011/en/index.html [Accessed June 30, 2012g].

Wilson, D.J. et al., 2009. Effects of Assistive Technology on Functional Decline in People Aging With a Disability. *Assistive Technology*, 21(4), pp.208ï 217.

APPENDIX A

1. Enable Ireland Research Ethics application

1. GENERAL INFORMATION		
1. Project Title	**Can a self assessment tool for environmental controls which has been informed by users be of benefit to potential users? (title may change)**	
2. Applicant Details	**Name**	Sean Loughran
	Type of Applicant	**Service User:**
		Staff: Clinical Technician with the National Assistive Technology Training Service for over 10 years
		External (If external, academic institution, department, etc.):
3. Supervisor Details (if applicable)	**Name**	Robert Ross
	Title	Lecturer in the School of Computing at the Dublin Institute of Technology (DIT)
4. Enable Ireland Details	**Centre**	National Assistive Technology Training Service
	Staff Contact	Siobhan Long
	Local Service Manager	Siobhan Long

	Local Director of Services	Hilary Devlin
5. Duration of Project	**Start:** February	**Finish:** July
6. External Sites		
2. SERVICE USER PARTICIPATION		
Participant involvement in Study Design & Implementation Will service users/staff be involved in the design/implementation?	The dissertation aims to develop a self-assessment tool which will be informed by the feedback of (i) Users who use or who have used Environmental Control Systems (ECS), (ii) Enable Ireland staff consisting of therapists and technicians who are involved in the service delivery of environmental control systems and (iii) Environmental Controls suppliers/installers. Participant involvement of service users and staff members will be an interview to inform the design of the self-assessment tool and/or after the development of the self-assessment tool to evaluate it and provide feedback via an interview. Measurement will be drawn from the benefits it will have for the potential user. A post evaluation will be explored to see if the physical hardware matches the users view of the self assessment tool's output.	
Participant Initial Contact Describe your plans for contacting service users/staff members	First contact the local service managers to request initial contact with service users and staff. Explain the rationale and aims of the study and provide a participatory invitation letter.	
Voluntary Participation How will you assure service users or families that whether they agree to participate or not, will not in any way affect their present or future service?	At the participant initial contact and within the participatory invitation letter it will be made very clear that it is voluntary participation and that whether they agree to participate or not, will not in any way affect their present or future service.	
Meeting with Participants	The meeting for service users ideally should take place within	

If your research involves meeting with the service user or family, where and when will this happen?	the home so that environmental control technology and any associated issues can be accurately identified. Meetings for staff members will take place within their workplace.
Confidentiality How will you assure service users or families that their confidentiality will not be compromised in any way?	Service users/staff responses will be anonymous in the dissertation, thereby protecting their identity and ensuring confidentiality. This will be highlighted within the Participant invitation letter.
3. AIMS & OBJECTIVES	
Overall Aims The purpose of your research – what are you trying to discover / prove / achieve?	On a personal level my choice of this topic was that I feel there is an under-use of ECS. Technology has developed considerably in this area and now offers great benefits to potential users to increase their choice, independence and hence their quality of life. My aim is to increase awareness within this area and provide a tool to assist in the selection of devices. The purpose of the research is to develop a self-assessment tool which will be informed by the main stakeholders and to prove that it can provide benefits for potential users.
Specific Objectives	➢ Obtain relevant information to develop a self assessment tool from the main stakeholders of an ECS installation. ➢ Develop the self assessment tool 4. Evaluate the tool in relation to the benefits it can have for the potential user.
Hypothesis	The hypothesis is that a self assessment tool that has been informed by relevant stakeholders can be of benefit to potential users of ECS by providing assistance with device selection of ECS devices.
4. METHODOLOGY	
Study Design	This study will be performed using qualitative methods. Enable Ireland service users will be interviewed within their home or

Quantitative, Qualitative, Mixed Methods, etc.	Enable Ireland Centre to find out a range of information such as ñwhat equipment they use in the homeò, ñhow well does it workò, ñservice deliver methodsò, and ñhow they think the self-assessment tool should be designedò. Enable Ireland staff that have been involved with service delivery of ECS will be interviewed within Enable Ireland to obtain information around ñhow well do ECS workò, ñservice deliver methodsò, and ñhow they think the self-assessment tool should be designedò. Interviews will be analysed and a self assessment tool will be developed based on findings. For service users the interviews will be analysed to enquire what they have within their home, how well does it work for them and their opinions around the design of the self-assessment tool. For staff members interviews will be analysed to identify what aspects of the user characteristic, environmental characteristics and technology characteristics they need to identify in the process of product selection. Their opinions around the design of the self-assessment tool will also be analysed. Although interviews may be recorded for accuracy of the information they will not be transcribed. Evaluation of the tool will be performed by users, staff (and ECS suppliers). These participants may be different participants from the ñinforming the designò stage as the evaluation is not dependant on the initial users. The evaluation will consist of the users trialling the self-assessment tool and then interviewing the participants to obtain feedback on how effective the tool is with device selection and their satisfaction with using the tool. **Step by step phased account of what the sample groups will be expected to do** • Participant Initial Contact; I will explain the rationale and aims of the study to service users and staff (potential participants) and provide a participatory Invitation letter. • For service users and staff that accept the invitation to participate in the study there will be asked to sign a consent form. • Plan suitable time and venue for the meeting/interview. Note: For service users this is ideally done within their home where they have the environmental controls in place. The main reasons for this is that some service users may not know exactly the type of equipment they have installed and also it will be easier to capture issues

	that the client may have. However I will rely on the advice of the local service manager in relation to the location of the Service User interviews. For Staff member the interview can take place within their local Enable Ireland Centre. ➢ Conduct the interview/meeting for 30 minutes at max. ➢ After the implementation of the self-assessment tool users and staff will be asked to evaluate the self assessment tool in relation to its usefulness. This will involve trialling the tool and providing feedback.	
Participants	**Nature**	
	Number	15 service users and 6 staff members
	Inclusion Criteria	In relation to staff members inclusion criteria is that they have experience in providing recommendations of ECS to service users. In relation to Service Users participation, criteria is that they are over 16 years of age Also that they use or who have used Environmental Control Systems within their home. This could be anything from a door intercom system to a full environmental control system within their home. The services that I will approach will be children's (over 16 years) and adult services in Galway, Cork and Dublin. Local service managers can determine who possible participants are based on service users which are over the age of 16 years and that they have a willingness to participate.
Instruments/Measures you should include a copy of any questionnaire, interview schedule, test, etc with your application	Interview questions for service users are at within the appendix. Questions for the evaluation stage will be based around the effectiveness and satisfaction of using the self assessment tool. Evaluation questions will be finalised and submitted after the design of the self assessment tool.	
Time-frame Please provide a detailed schedule of the tasks involved throughout the research	Time-frame detailed within the appendix below	

project (you may include a Gantt Chart as an Appendix)	
Statistical Methods Please provide detailed account	This will be based around satisfaction ratings of using the self-assessment tool.
Procedures which may cause discomfort/distress Does your research include procedures that may cause discomfort or distress? If so, please describe.	No procedure is expected to cause discomfort or distress. If any discomfort or distress is apparent within a meeting it will be stopped immediately.

5. INFORMED CONSENT & ASSENT		
Will you be seeking Informed Consent? If not, please justify?		
Participant Information Have you prepared an Invitation Letter and Information Sheet? Please include copies of the relevant materials as an Appendix.	**Invitation Letter:**	See appendix below
	Information Sheet:	See appendix below
Signed Informed Consent Have you prepared a Consent Form? Please include copies of the relevant materials as an Appendix.	See appendix below	
Signed Informed Assent (if applicable) Have you prepared an Assent Form (agreement of young person) for participants under the age of 16 years. Please include copies of the relevant materials as an Appendix.	Not applicable	

6. DATA MANAGEMENT	
Who will have access to the data?	Access to interviews and audio recordings will be available solely to me and the examiner.
What media of data will be collected?	**Audio and Transcripts:** Interviews will be recorded with participantôs permission to ensure accuracy of information. Transcribing interviews is not required.
	Photos and Videos: Photos will only be taken of equipment.
Data Classification	**Anonymous:** Users and staff will be anonymous for this research.
	Pseudonymised:
	Coded:
	Identifiable:
Data Protection	**Storage:** Laptop
	Security: Personal laptop will be encrypted using TrueCrypt
	Confidentiality: No names will be used and data obtained from interviews will only be used to inform this research
	Retention: Mid September
	Destruction: Complete deletion of data
	Within Enable Ireland by myself

Where will Data Analysis take place, and by whom?	
7. OUTCOMES/BENEFITS FOR ORGANISATION	
How does this research align with our Strategic Objectives?	The research will provide information and tools within the area of Environmental Control Systems. These systems increase a userôs active abilities, their independence and their choice. This aligns to Enable Ireland's Strategic Objective to support service users in achieving inclusion and independence within their communities. The self assessment tool will align to the Strategic Objective by providing timely, accurate and accessible information in the area of ECS to service users and other stakeholders.
How will this research inform local and/or national Service Development?	The research will inform local service development by highlighting the benefits of a self assessment tool for ECS from a userôs perspective.
Will Enable Ireland be identified in your study and if so, how?	Yes, with Enable Ireland's permission I will identify Enable Ireland as contributing to the design of the self assessment tool and to the evaluation of the self-assessment tool.
8. DISSEMINATION	
Please comment on how the results will be fed back to individual participants.	A summary document of the study will be sent to all participants. It will explain how participants informed the design of the tool and how the tool measured through the evaluation process.
Please comment on how aggregated study results will be made available to Enable Ireland	A summary document of the results will be made available. This will include the background to the research, the analysis of the data and the results of the evaluation of the self assessment tool.
Please describe your wider dissemination	The self assessment tool will be made

strategy	available within the public domain. If the research has shown that the self assessment tool can be of benefit to potential users of environmental control systems by providing guidance of ECS devices then it will be hosted as an online self assessment tool. Paper proposals will be submitted to relevant conferences.

2. Invitation letter

Hi,

I am working within the National Assistive Technology Training Service of Enable Ireland and am studying part-time for an MSc. in Computing (Assistive Technology). As part of my study I am researching if a self-assessment tool in Environmental Control Systems can provide benefits to potential users in selecting appropriate devices within this area.

You are invited as a participant in this study. Your involvement as a participant will be to provide feedback via an interview in order to inform the design of the self-assessment tool and/or within the evaluation of the developed self-assessment tool. The interview can take place within the home or at the local Enable Ireland Centre at an agreed date. It will be audio recorded with your permission to ensure accuracy of information. Responses will be anonymous in the study, thereby ensuring confidentiality.

The benefits of the study are that it will contribute to further developing service delivery in Environmental Control Systems for future users.

Participation is voluntary so if you agree to participate or not it will not in any way affect your present or future service with Enable Ireland. You can change your mind at any time and withdraw from the study.

However your participation would be greatly appreciated. If you agree to participate or have any questions in relation to the study please contact me at the details below;

3. Information letter

TITLE OF PROJECT: Can a self-assessment tool for environmental controls which has been informed by users be of benefit to potential users?

THE PROJECT IS BEING CARRIED OUT BY: Sean Loughran as part of a dissertation with the Dublin Institute of Technology.

THE PROJECT IS ABOUT: Evaluating the benefits of a self-assessment tool for potential users of Environmental Control Systems. The design of the self-assessment tool will be informed by service users, staff and environmental control systems suppliers. The purpose of the self-assessment tool will be to assist with the selection of Environmental Control devices.

Your involvement as a participant will be to provide feedback via an interview in order to inform the design of the self-assessment tool and/or within the evaluation of the developed self-assessment tool. The interview can take place within the home or at the local Enable Ireland Centre at an agreed date. It will be audio recorded with your permission to ensure accuracy of information. The information collected will be used to inform the design of the self-assessment tool and to evaluate the benefits of the tool. Service users / staff responses will be anonymous in the study, thereby protecting your identity and ensuring confidentiality.

The benefits of this study are that it will explore an alternative approach to service delivery of environmental control systems in the hope to improve service delivery in this area.

Responses to the interviews will be anonymous in the study, thereby protecting your identity and ensuring confidentiality. This research has been approved by the research ethics committee within Enable Ireland.

Your participation is voluntary so if you agree to participate or not it will not in any way affect your present or future service with Enable Ireland. You can change your mind at any time and withdraw from the study.

If you have any questions in relation to the study please do not hesitate to contact me

4. Consent form

TITLE OF RESEARCH PROJECT: Can a self-assessment tool for environmental controls which has been informed by users be of benefit to potential users?

NAME OF RESEARCHER: Sean Loughran

- I confirm that I have read and understood the information sheet for the above study and have the opportunity to ask questionsYES/NO*
- I understand that my participation is voluntary and that I am free to withdraw at any time, without having to give any reason, and without any way affecting my present or future service with Enable Ireland YES/NO*
- I agree to take part in the above study. YES/NO*
- I agree for the interview to be audio recorded. YES/NO*

_____	_____	_____
Name of Participant	Date	Signature

_____	_____	_____
Name of Researcher	Date	Signature

*Please delete as appropriate

5. Questions for the Therapist or AT resource person

Characteristics and requirements of the person

- Which areas do you need to know a personôs functional ability i.e. how they perform in the following areas (If you think there is a need to discuss point further please do)

    - Speech/communication, yes/no
    - Mobility, yes/no
    - Dexterity and hand control, yes/no
    - Eyesight, yes/no
    - Hearing, yes/no
    - Reading/ writing, yes/no
    - Understanding, remembering yes/no
    - Household activities, yes/no
    - self-care yes/no
    - Are there any missing functional ability areas required?, discuss

- How do you determine the personôs strengths and limitations in relation to the functional areas above?
  (i) Ask people to rate their strengths and limitations, (ii) rely on the person's therapist (iii) other
- How do you determine their goals (what they wish to do)?
  (i) ask person what they wish to control, (ii) discuss with their therapist or (iii) other
- How do you decide if the intervention to meet a person's goal is best met with a relevant technology or an environmental accommodation? E.g. ñuse remote control to activate lightò versus ñadjusts light switch heightò. discuss
- Do you need to know what technology (or other supports) a person currently uses, or have used? Yes/no
- If so do you need to know the level of satisfaction they had with the technology?
- And do you need to know the reason why they no longer are using the intervention? Yes/no
- How do we find if the person perceives the intervention as meeting their goals? Ask them what they think about the technology, discuss.
- Do you need to know if a person prefers to ñdo things alone and experimentò or ñhave someone else help themò because of the desire for interpersonal contact? (i.e. the blend of autonomy and support from others the person wishes to achieve) Yes/no
- How can you tell if a person is receptive to the use of technology? discuss
- Do you need to know if the person has a need to change from the current situation? Yes/no

- Do you need to know if the person is generally ñhappy and composedò or ñsad and anxiousò? Yes/no
- Do you need to know what the personôs typical routines are? Yes/no
- Do we need to know what other member of the family can do within the home? Yes/no

Characteristics and requirements of the milieu/environment

- Is there a need to be aware of the family culture within the home?
- Do you need to know what the supports are within the family or other supports that may be available to the person? Yes/no
- Does the level of support available for the person affect the choice of ECS technologies? Yes/no, discuss
- Do you need to know the receptivity of other family member with the installation of equipment? Yes/no
- Do you need to be aware of any local funding or grants that the person may avail of? Yes/no

Characteristics of the technology

- What factors do you have to be aware of within a technology for example cost, durability, input options, output options? Discuss
- Is age-appropriateness with equipment an issue with ECS? Yes/no
- Are adjustments or setup time of equipment an important consideration? Yes/no
- How would you determine if a person may feel self-conscious in using a piece of technology? Yes/no
- Is there particular technology that may cause fatigue, strain, or pain? Yes/no, discuss
- Is compatibility an issue when introducing new ECS? Yes/no
- Do you have to consider the impacts that new technology will have on other members of the home? Yes/no
- Does the person need to be made aware typical repair cost? Yes/no

General questions

- Are the person and the supplier always present when selecting ECS? Yes/no
- Do you see the environmental control systems generally confined to the home environment? Yes/no
- What process do you use for the selection of ECS devices? discuss

The self-assessment tool

- Do you think a self-assessment tool should be paper based or an online resource? (i) paper based (ii)or an online resource
- Designed for the user to work independently or to be used together with other

stakeholders (therapist, family, friends, installer) (i) independently (ii) with others

- Should device selection provide details on ñbest matchò only or on a number of possible products that the user can further select from.
  (i) Best match (ii) or a number of products
- Should self-assessment tool results as well as identifying a product *also* provide relevant information around the identified products (e.g. general information on door openers and/or a link to a video of someone using a door opener). YES/NO
- How many questions are acceptable for the self-assessment tool to ask the user? Less than 10, 10-20, more than 20) E.g. what do you need to be able to control within your home? Can you manipulate a standard remote control? Do you have a budget limit? max number
- What scope should the self-assessment tool find information on (dedicated transmitters, transmitters built into communication machines or other portable devices, mobile phones, PC access, door openers, window openers, curtain openers, light control, heating and ventilation controls, security, assisted living controls) Is there anything else that should be included or anything here excluded from list? Scope

Other possible features of the self-assessment tool

Below are other features that a self-assessment tool could also have.

Rate these features in terms of importance (not so relevant 1----------7 very necessary)

- Is there a need for a self-browse section on the self-assessment tool where products can be browsed by category, listed and selected? (1-7)
- Comparison of products (1-7)
- View user ratings on different products or rate and comment on products themselves (1-7)
- Should the self- assessment tool retain information via a userôs login so that a userôs device section results can be later retrieved? (1-7)
- A discussion area for users and potential users to talk about issues (1-7)
- Are there any other information resources related to ECS that would be useful e.g. funding options, programming of transmitters etc.

Comment

- Do you have any other suggestions on how a self-assessment tool should work or other features that should be included?

6. Summary of interviews

Users

- Both users have current problems with door openers
- Both rate their satisfaction of the equipment as high
- Both felt that tool should be an online tool
- Both felt that the tool should be suitable for the user to work alone as well as a tool desigh for the user and other stack-holders to use it together.
- Split on the idea of best match vs a number of products
- Both wanted detailed results
- Less than 20 questions to ask the user
- Both indicated to include everything
- Would like to see various formats within the results, particularly video is seen as being useful, with videos on how to use the product or how to care for the product.
- One user uses dragon naturally speaking and the other user uses alternative keyboard and mouse (compact keyboard and joystick).
- Other information resources the users said would be useful are
    1. accessories for the transmitters such as covers personalise or new batteries
    2. having information relating to how they can dial emergency services through the technology
- Other comments
    1. Rate the providers

Therapists

- Both therapists said they need to know a personôs functional ability of all items

  Speech/communication, yes

  Mobility, yes

  Dexterity and hand control, yes

  Eyesight, yes

  Hearing, yes

  Reading/ writing, yes

  Understanding, remembering yes

  Household activities, yes

  self-care yes

- Other functional abilities

1. Controlled body movement? For example for switches
2. Can they use head switch or eye gaze
3. Abilities to use other assistive technologies, i.e. their ability to use computers, power wheelchairs, mouth sticks or other aids

- The therapists determine the strengths and weaknesses of the functional abilities of an individual by a combination of asking the individual questions and looking for demonstrations of abilities. In some cases the therapists may consult with carers or family members in relation to their abilities.

- To determine the individual goals the therapists ask the user what they want at the same time as educating the user of what technologies can do for them. Video demonstration as well as showing product pages within websites.

- In terms of deciding if the intervention to meet a person's goal is best met with a relevant technology or an environmental accommodation it one therapist emphasised considering low tech solutions first such as extended handles or better grip options however other therapists said it was really dependent on the situation such as the client needs, the financial situation and the persons main goals. For example if a person's main goal is to turn on a light switch then replacing the light switch with a large on/off switch may be all that is required however if the person has other goals which involves more remote control then tying the whole thing together in a package may be a better solution.

- In terms of needing to know what technology (or other supports) a person currently uses, or have used this is useful to know as it may be possibly to use existing technology such as wheelchair controls or AAC devices within the ECS. Also it may provide the therapists details of the level of complexity of technology the user is comfortable using.

- Knowing also the level of satisfaction they had with the technology is needed in order to find out if there is a possibility that the device may be extended to work with additional remote controls devices or on the other hand if it did not work out, this type of technology may need to be avoided. Although nothing too detailed required.

- It is useful to determine the reason why they are no longer are using the intervention to see if the device was too complex, or is training required rather than a new solution.

- To find if the person perceives the intervention as meeting their goals, this is accomplished by the trialling of equipment and discussing about the technology after the trial period. This opens up the question of whether the self assessment tool should be open to multiple intervention sessions where a user is

recommended equipment and provides feedback to the tool when after recommended equipment has been trialled.

- Therapist do feel there is a need to know if a person prefers to ñdo things alone and experimentò or ñhave someone else help themò i.e. knowing the blend of autonomy and support from others the person wishes to achieve. However this requires establishing an interpersonal relationship with the client as well as the carers or family members and judging the importance of family members or carers for user and what they do for them during the day. Cannot be measured well using the tool.

- We can tell if a person is receptive to the use of technology by see if they have had previous successes with technology or if they perceive a need for technology
- Instead of finding out if the person has a need for change see if the person is open to change

- In terms of know whether if a the person is generally ñhappy and composedò or ñsad and anxiousò this may have an impact but is not a major focus

- In terms of knowing what a personôs typical routines are this can be useful.

- there is a need to be aware of the family culture within the home

  (In terms of the self-assessment tool what do I need to know in relation to family culture? Is there a supportive environment?, Does the user have autonomy within the home environment?, This will require too many questions and really needs to be observed within the family environment rather than just asking the user questions.)

- you do need to know what the supports are within the family or other supports that may be available to the person for training purposes, and support afterwards as user may not have taken everything in at installation. The level of support available for the person affect the choice of ECS technologies

- You do need to know the receptivity of other family member with the installation of equipment. For example door openers need a bit of patients or people will just end up disconnecting them.

- In terms of needing to be aware of any local funding or grants that the person may avail of this is handy to know but may not have a relevance.

- The factors that you have to be aware of within a technology are aesthetics; does it have a mainstream appearance, simplicity; is it easy to use and easy to

understand how to use it, waterproof, battery life, how things are mounted; are they discreet, displays can you see them in the sunlight. rugged if it going to be handled roughly, insurance, extended warranty, flexibility of device, can you add on more features, options for output text or symbols

- Age-appropriateness is important with ECS equipment. Children are likely to prefer colour, while older people may prefer black or duller colours.

- As for the set-up time being important issue there is a mixed opinion between the therapists as one feels its not a big concern while the other felt it was very important.

- The method used by the therapists to determine if a person may feel self-conscious in using a piece of technology is to see if client is comfortable in using the technology in a home environment but not in a public environment. It is a combination of self-report and observation of other behaviours such as first reactions, and facial expressions. (This canôt be measured without trialling the recommended equipment and so itôs another reason why a self-assessment tool may have to provide multiple intervention approaches and build up knowledge of each trial.)

- Therapists have said the some technology may cause either fatigue, strain, or pain. The use of mouth sticks can be quite straining or any switch if switch is selected poorly (such as switch site, mounting position or the type of switch itself) can cause strain or even looking at poorly mounted displays if mounted low

  (This does not really fit within the tool and its relevance to device selection. However it could be useful to provide general around device strain and fatigue that could result in pain. Or a general question ask if there was multiple intervention approach.)

- Both therapists were not aware of any compatibility issues with ECU equipment except for communication technologies such as blue-tooth, radio, IR.

- In terms of considering the impacts that new technology will have on other members of the home, it is not primary concern except in the case of door openers they require patience form others
- In terms of informing the person of typical repair cost this is important if the equipment will be is private funded. (however suppliers have said that most equipment is reliable except for external doors)

- When selecting ECS the end user is always present and the supplier is present if possible.

- Therapists have said that environmental control systems generally confined to the home environment but can be seen in clinics settings , day care centres, independent living centres respite centres

- The process use by therapist does cover a lot of what has been mentioned although it tends to be more an iterative process as various equipment may need to be trialled and client monitored. Information gathering may be done over stages. By introducing things to people you can get a different picture each time.

Suppliers

- The role of the supplier varies from just supplying equipment that has been prescribed by a health professional to on the other hand where they are heavily depended on to provide advice around device selection for an individual. This is dependent on the knowledge and experience of the therapist. For the installer it is normal to have both the potential ECS user and the therapist present when choosing an ECS.

- The characteristics of a technology that an individual should be aware is how the equipment is accessed in other words how they are going to control it and what can it do for them. (both suppliers seems to misunderstand this question)

- Both suppliers feel that age appropriateness is an important aspect. Young people tend to like a more sophisticated device such as a smart phone or an iPad where this type of technology is second nature for them. It also allows them to do many other things. Whereas an older person it may be more appropriate to have less technical interface with a couple of functions. Also for young people they may have more of interest in controlling the their entertainment systems rather than control and their lights or shut doors. An older person is unlikely to have the same desire to control the sky channels and more interested in controlling and lights and doors.

- For the supplier/installer the technologies that take considerable set-up time are the transmitters. Transmitters need to be customised around the individual which may involve creating various pages or grids on it to control all the appliances required. Setting up a TV or a telephone can also take long. Afterwards people may want to change pre-stored numbers within their telephone or change their TV set which will require reprogramming. However everything else is straight forward and fixed.

- No particular technology itself will cause fatigue, strain, or pain except for maybe eyegaze. Fatigue or strain is more related to the persons condition. Constant switch activation can cause a problem. The appropriate switch must be used and mounted in the correct position so as to allow the least amount of exertion for the user to operate. Also this selection method for a devices can be an important issue. In terms of strain on the eyes lighting conditions or screen size have an impact. (similar response as the therapists)

- Compatibility of technologies is not really too much a problem. There may be the occasional TV that may have difficulty recording the infra-red commands or an issues with door openers that is not suitable for the structure of the building. Infra-red seems to be a quite good standard.

- Generally environmental control systems are used mainly within a persons home, although requests can be made the transmitter be set up so that they can control devices in alternative locations such as holiday home or a centre that they attend. Other possible locations are care homes, hospitals, hospices and schools.

- The main structural prerequisite for installing ECS equipment are that door lintels (the area above the) must be strong for door operators. Also spurs need to be placed in the right place in order to operate door operators, window and curtain operators. Also wiring for the elbow push pads (switch to open the door) and wiring for the door latch.

- In Ireland infra-red is the main type of environmental control systems used in the disability area. However within Europe there are some bus systems used for ECS, such as the Siemens EIB bus system and the Z-Wave wireless bus. However infra-red is the most cost-effective and reliable. It also has a built in safety feature in that if you can't see the technology you can't control it as infra-red is line of sight control.

- Some aspects of an environment control systems will affect other members of the family in particular door openers or door intercom systems.

- Most ECS equipment do not tend to require frequent servicing, but there tends to be more of a need for frequent tweaking as people want to do more things with their system or add more new devices. However door openers can require occasional servicing as doors can swell and stick due to rain.

- Suppliers/installers are not confined to a certain brand of transmitters as they are agents for many ECS manufacturers. So its mainly based on what suits the users needs and preferences. However suppliers tend to stick to the one door opener or window opener etc. that works of them. It saves having to be familiar with lots of product or carrying a lot of serviceable parts.

- Suppliers have said that the self-assessment tool should be both paper based and an online tool but see the online tools as the best way for the user to access information and the easiest way to show pictures and details on products.

- Ideally the self-assessment tool should be made so that it as simple as reasonably possible and accessible to as many people as possible to use by themselves. User may find it difficult to use but a therapists may find it a simple tool and a good way to explain the options to the client.

- Tool should display a number of products in the results in order of preference.

- Comprehensive results required

- In terms of the number of questions that a self-assessment tool can ask it depends on the client. Rather than being limited on the number of questions it should be limited on time to about ½ max.

- Suggested that the scope should consider switches and mounting options.
- Other suggested features that should be included into the self-assessment tool is information to help people understand how to get technology. Tool should provide locally based information. Such as you may need to first get referred by a local GP or therapist. If someone wants to fund it privately then the tool could take them directly to information to suppliers where a supplier can provide the assessment.

Other possible features of the self-assessment tool

Features	*User 1*	*User2*	*Therapists1*	*Therapists2*	*Supplier1*	*Average score*
Self-browse section	5	3	6	7	6	5.4
Comparison of products	3	5	6	6	7	5.4
User ratings	4	6	5	7	1	4.6
User's login	6	5	4	5	5	5
User discussion area	6	3	6	4	2	4.2

7. Evaluation Questionnaires

Scale 1 to 7 (1: poor, unsatisfied ï 7: good, satisfied)

Users who use the tool

Pre evaluation questions

1. Name of user
2. Do you have any difficulty controlling equipment at home such as lights, windows, curtains, TV, opening and closing doors, answering the front door? Yes/no
3. Do you already use environmental controls within your home? Yes/no
4. How would you rate your awareness or knowledge of environmental controls systems 1-7
5. How good do you think an online self assessment tool could be at assisting with device selection for environmental controls? 1-7
6. How confident would you be that it would provide accurate information?
7. Do you think an assessment with a therapist would be better for assisting with device selection of environmental controls? Yes/no
8. Do you think, it would be and advantage for you to find out more about possible solution before you meet an assistive technology resource person or therapist yes/no

Post evaluation questions

How well did the self-assessment tool preform?

1. How would you rate you knowledge of environment control systems now (1-7)
2. How well do you think the tool identified correct products for you (1-7)
3. How well did the tool provide appropriate advice for you (1-7)
4. How confident are you that you have been provided accurate information?
5. How would you rate the process of using a self assessment tool to assist in the recommendation of Environmental control products? (1-7)
6. Overall how good do you think the online self assessment tool was at assisting with device selection for environmental controls? 1-7
7. Do you think an assessment with a therapist would be better for assisting with device selection of environmental controls? Yes/no
8. What are the advantages of using this tool for you? Comment
9. Are there disadvantages with using the tool? Comment

Satisfaction level

Can you rate you satisfaction of using the tool with regard to with the following

10. Being able to access and use the self-assessment tool (1-7)
11. Satisfaction with completing the questions(1-7)
12. Satisfaction of the device recommendation and the advice that the tool provides you?(1-7)
13. Overall satisfaction with the tool (1-7)

Post use

14. How well do you trust that the tool has provided accurate device selection and advice(1-7)
15. After seeing the report from the self-assessment tool would you know what to do next or who to contact if you were interested in getting a device? Yes/no
16. Do you still feel a need for a therapist involvement? Yes/no

Other possible features

17. Is there a need for a self-browse section on the self-assessment tool where products can be browsed by category, listed and selected? (1-7)
18. Comparison of products (1-7)
19. View user ratings on different products or rate and comment on products themselves (1-7)
20. Should the self- assessment tool retain information via a userôs login so that a userôs device section results can be later retrieved?(1-7)
21. A discussion area for users and potential users to talk about issues (1-7)
22. Are there any other information resources related to ECS that would be useful e.g. funding options, programming of transmitters etc.
23. Do you have any other suggestion or comments to make?

Users who don't use the tool (Gold standard)

Pre evaluation questions

1. Name of user
2. Do you have any difficulty controlling equipment at home such as lights, windows, curtains, TV, opening and closing doors, answering the front door?
3. Do you already use environmental controls within your home?, If so what do you use or control?
4. How would you rate you knowledge of environment control systems1-7
5. How confident are you that you will be provide accurate information?

6. Do you think an online tool rather than an assessment with a therapist would be better for assisting with device selection of environmental controls? Yes/no
7. Do you think, it would be an advantage for you to find out more about possible solution before you meet an assistive technology resource person or therapist yes/no

Post evaluation questions

1. How would you rate you knowledge of environment control systems now(1-7)
2. How well do you think the therapist identified the correct products for you? (1-7)
3. How well did the therapist provide appropriate advice for you? (1-7)
4. How would you rate the process of using a therapist to assist in the recommendation of Environmental control products. (1-7)
5. How confident are you that you have been provide accurate information?